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ORIGINAL ARTICLES.

I. — The Genus *Desorella*.

By Henry Woods, M.A., F.G.S.

(PLATE XVI.)

THE genus *Desorella*[1] was founded by Cotteau in 1855 to include four species from the Corallian named *D. icaunensis*, *D. Orbignyana*, *D. elata*, and *D. Drogiaca*, and one from the Neocomian—*D. incisa*. The first and the last of these five species were subsequently shown to belong to the genus *Pyrina*, the second was placed by Etallon[2] in a new genus, *Pseudodesorella*, whilst the fourth has been referred to *Hyboclypeus*. So that of the five species originally regarded as belonging to *Desorella*, one only, *D. elata*, is left in that genus. Another species, described in 1862 as *Desorella Guerangeri*,[3] was afterwards shown to be a *Pyrina*. Cotteau[4] accepted these modifications, and, in 1873, gave an emended diagnosis of the genus, naming as the type *Desorella elata*, and describing another species, *D. Grasi*. M. Jules Lambert is of the opinion that *Pachyclypeus semiglobus* (Goldfuss[5]) should be placed in the genus *Desorella*.

All the specimens of *Desorella elata* and *D. Grasi* which have yet been described are in the form of internal moulds, consequently the characters of the genus have been hitherto only imperfectly known, so that there was some justification for Duncan's remark, "This is now a very unsatisfactory genus."[6] The description of *Desorella* given below is based on a specimen with the test preserved which was found in the Corallian of Upware. An examination of this specimen supports the view that *Desorella* is closely allied to *Pyrina*, from which it is readily distinguished by its depressed and suborbicular form. Duncan[6] placed *Desorella* in the Nucleolitidæ,

[1] Originally *Desoria*.

[2] Etudes paléont. Terr. Jurass. du Haut-Jura, pt. ii (1859), p. 16.

[3] Cotteau: Rev. et Mag. de Zool., ser. II, vol. xiv (1862), p. 193.

[4] Paléont. Franç. Terr. Jur., vol. ix, pp. 333, 384.

[5] Desor: Synopsis Echin. Foss. (1857), p. 195, pl. xxxvii, figs. 3, 4. Cotteau: Paléont. Franç. Terr. Jur., vol. ix (1873), p. 390, pl. ci. Desor & De Loriol: Echinol. Helvét. Jurass. (1871), pp. 300, 405, pl. xlvi, fig. 6.

[6] "Revision of the Echinoidea": Journ. Linn. Soc. Zool., vol. xxiii (1889), p. 179.

but as of uncertain position. The simple ambulacra and elongate apical disc clearly separate it from that family. There can, I think, be no doubt that it should be referred to the Echinoneidæ, as was done by Desor, De Loriol, and Cotteau. *Desorella* is also related to *Hyboclypeus*, but is distinguished from it by the absence of a dorsal sulcus.

Desorella elata (Desor). (Plate XVI.)

Synonymy.

1847. *Hyboclypus elatus*, Desor: in Agassiz & Desor, "Catal. raisonné des E'chinides," Ann. Sci. nat., ser. III, vol. vii, p. 152.
1855. *Desoria elata*, Cotteau: E'chin. Foss. de l'Yonne, vol. i, p. 228, pl. xxxiv, figs. 1–3 (*Desorella* on p. 344).
1855. *Desorella elata*, Cotteau: Bull. Soc. géol. France, ser. II, vol. xii, p. 713.
1857. *Desorella elata*, Desor: Synopsis E'chin. Foss., p. 194.
1873. *Desorella elata*, Cotteau: Pal. Franç. Terr. Jur., vol. ix, p. 386, pls. xcviii, xcix, figs. 1, 2.

Description.—Test large, subcircular, subrostrate and slightly truncate posteriorly, flattened, aboral surface regularly convex, margins rounded. Apex slightly posterior to the centre. Base concave, distinctly undulating; peristome sub-pentagonal, oblique, placed a little in front of the centre. Periproct large, ovate, at the posterior end and extending to the margin of the aboral surface; dorsal sulcus absent, the test depressed around the lower part of the periproct.

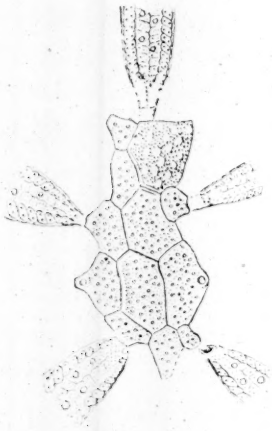
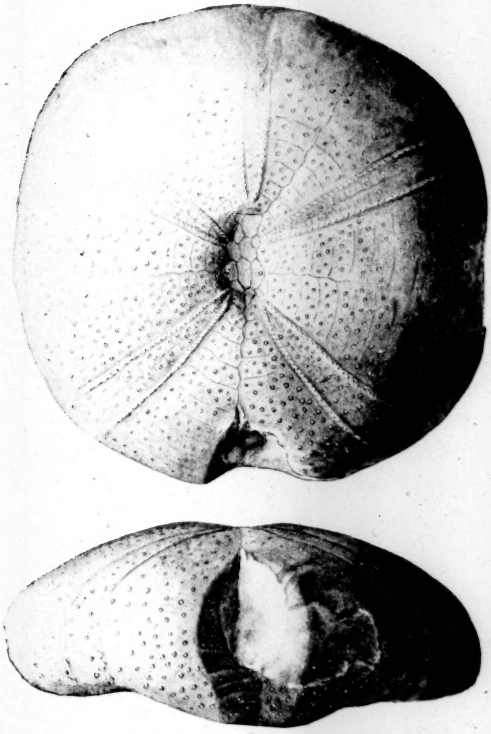


Fig. 1.—Apical disc of specimen shown in Plate XVI. × 3.

Apical disc elongate, slightly depressed, all the plates bearing small granules. Anterior ocular indistinctly shown. Madreporic plate large, in contact with the left anterior genital, which is divided into two parts. Right antero-lateral ocular smaller than the left, and separated from it by a large, nearly hexagonal, complementary plate which touches, in front, the madreporic plate and the left anterior genital plate. Postero-lateral genitals large, separated



Desorella elata (Desor).

Corallian: Upware, near Cambridge. Nat. size.

from the anterior genital plates by the antero-laterals and the anterior complementary plate. Another large complementary plate, which is elongate and hexagonal, separates the postero-lateral genitals. The posterior oculars are small, the left being larger than the right; between them comes the posterior genital, of which the posterior boundaries are indistinctly seen.

Ambulacra not petaloid. The pores of each pair are slightly oblique, the outer being aboral to the inner. The inner pore is rather larger than the outer. On each plate one or more small, sunken tubercles, which are perforate, increnulate, scrobiculate, and well-spaced. Between the tubercles are many granules.

Interambulacra broad, the postero-laterals being rather larger than the antero-laterals. Plates with many tubercles and granules similar to those of the ambulacra.

The specimen was found in the Coralline Oolite of the lower part of the south quarry at Upware, and is now preserved in the Sedgwick Museum, Cambridge. The genus has not hitherto been recorded in England. The types of *Desorella elata* came from the Lower Corallian (Calcaire à chailles) of Yonne.

EXPLANATION OF PLATE XVI.

Desorella elata (Desor). Corallian: Upware, Cambridgeshire. Aboral and posterior views. Natural size.

II. — Note on the Barypoda, a new Order of Ungulate Mammals.

By C. W. Andrews, D.Sc., F.G.S., British Museum (Natural History).

In a notice published on page 160 of the present volume it was suggested that *Arsinoitherium*, of which a brief description was there given, must be placed in the order Amblypoda, constituting a new family, the Arsinoitheriidæ. Having further considered the evidence available, and having, moreover, had the advantage of some discussion on the subject with Professors H. F. Osborn and W. B. Scott, I have now come to the conclusion that *Arsinoitherium* differs from the Amblypoda in so many points that it seems necessary to refer that remarkable mammal to a new subdivision of the Ungulata of equal value with the Amblypoda and Proboscidea, to both of which a certain degree of relationship may exist. For this new order the name *Barypoda* is proposed, in allusion to the massive character of the limbs in the species at present known. The existence of two orders so marked as the Proboscidea and the Hyracoidea in the Eocene beds of Egypt, and their absence at that period from the rest of the world (with the possible exception of South America), at least make it seem likely that in an area so isolated there were other equally distinct groups which died out before circumstances became favourable to allowing them to pass over to other regions. That *Arsinoitherium* may be the representative of such an order is probable, for its great size and highly specialised character point to its being the closing member of a long line, of which the earlier forms are at present quite

unknown, and must be sought in earlier horizons in the Ethiopian region.

The chief characters of the Barypoda are:—Full eutherian dentition without diastemata; molars bilophodont, a character probably produced by the infolding of the ectoloph of increasingly hypselodont teeth. In *Arsinoitherium* the molars are extremely hypselodont. Premolars differ widely from the molars. In the skull the occipital surface is strongly inclined forwards, and there are palatal and nasal horns, the latter of enormous size in *Arsinoitherium*. The orbits are open posteriorly. An alisphenoid canal is present. The brain cavity is relatively much larger than in the Amblypoda.

There is no entepicondylar canal in the humerus, and no third trochanter in the femur.

The fore-foot is much like that of the Proboscidea; thus the metacarpals alternate to the same extent as in *Elephas*, and the scaphoid is closely similar. In correlation with the fact that the radius is much smaller than the ulna, the difference in size being greater than in *Elephas*, the cuneiform is large and seems to have overlapped the magnum, while the scaphoid is relatively small.

The hind-foot differs widely from the Proboscidean type and approaches that of the Amblypoda. The astragalus and calcaneum both bear large fibular facets. The low and broad astragalus articulates distally with the navicular and cuboid, the latter having only a small surface of contact with the calcaneum. There was probably a small tibiale.

The feet were no doubt pentadactyl, the metapodials being short and stout. From the form of the calcaneum it seems probable that the heel sometimes rested on the ground.

The systematic position of the other genus, *Barytherium*, is still doubtful. It is clear that, from the character of its dentition, it cannot come within the limits of the Barypoda as above defined; moreover, as far as can be judged from the distal end of the radius, the carpal structure must have been widely different from both that of the Barypoda and Proboscidea, and was more similar to that of the Dinocerata. The humerus is of a most remarkable form, and its peculiar character indicates that possibly the fore-limb was used for digging or burrowing. For the present it will perhaps be safest to place this genus quite provisionally in a subdivision of the Amblypoda, the Barytheria, equivalent in value to the Dinocerata.

III.—On the Zone of *Marsupites* in the Chalk at Beddington, near Croydon, Surrey.

By George Jennings Hinde, Ph.D., F.R.S.

ON hearing that Mr. G. E. Dibley, F.G.S., had exhibited at the June meeting of the Geologists' Association some test-plates of *Marsupites* from the Chalk of a new road near Russell Hill, I made inquiries of him, and he most kindly told me the particular locality where he and others had obtained these fossils. As the place was within an easy walk of my home, I visited it, in company

with the younger members of my family, on an evening in June, and found, as Mr. Dibley had told me, that the greater part of the Chalk had been refilled into the sewer-trench, and the residue had been spread over the roadway and was now partly trodden down by the traffic. We patiently broke a number of the remaining blocks of chalk, and, in spite of the fact that Mr. Dibley had already carefully worked at the place, succeeded in finding not only a couple of plates of *Marsupites* with *Echinocorys scutatus*, etc., but also some smaller inconspicuous plates which, when cleaned from the matrix, proved to be test-plates of the unstalked, free-swimming crinoid, *Uintacrinus*, Grinnell. These showed the existence at this place of the lower portion of the *Marsupites*-zone, which has been designated by Dr. Rowe[1] the "Band of *Uintacrinus*."

Since last June another trench for sewerage, more than a mile in length, and from 20 to 25 feet in depth, has been in course of excavation along the northern half of Plough Lane, a road leading from Purley to Beddington, to which I have made repeated visits during the last two months, searching the Chalk exposed throughout, and the subjoined list gives the names of the fossils obtained.

The southern end of the trench is situated at the summit-level of the Chalk ridge between Purley and Beddington, where the new road mentioned above (known as Peak Hill Road) is given off, and it is about 200 yards south of the Keeper's Cottage, shown on the 6 inch Ordnance Map. The summit is about 325 feet above O.D., and from it there is a gentle slope towards the north, in the direction of Beddington as far as where Plough Lane is crossed by the Stafford Road, leading to Croydon, at a level of 193 feet O.D., and at this point the trench stops. The entire area is included in the boundary of Beddington parish.

At the summit-level of the ridge the Chalk is near the surface, being only covered by a few inches of brownish sandy soil, but lower down the northern slope it gradually passes beneath beds of brownish sandy loam, shown in the trench to a depth of 3–4 feet, which represent the lower portion of the Eocene Thanet Sand, and between the sandy loam and the Chalk there is in places a thin layer of the unworn, green-coated flints, known as the Bull's Head bed. The dip of the Chalk from the summit towards the north is probably about the same as that of the general slope of the surface. As far as can be seen, the Chalk in the Plough Lane trench is of the same soft, white character throughout; it contains but a moderate number of black, solid, nodular flints, with a thin white crust, which, I am informed, are principally from one layer, but small nodules are occasionally present elsewhere in the beds.

Fossils are very inequally distributed in this Chalk; in some parts of the section they are fairly common, whilst in others one may split open a number of blocks without finding any. The list given below is by no means complete, for the Microzoa have not been worked out. In determining the various forms I wish to

[1] Proc. Geol. Assoc., vol. xvi (1900), p. 291.

acknowledge the assistance freely given to me by my friend Mr. E. T. Newton, F.R.S., of the Jermyn Street Museum, by Dr. Bather, Mr. R. B. Newton, and Mr. W. D. Lang, of the British Natural History Museum, and by Mr. C. D. Sherborn.

List of Fossils.

Plantæ.

Linear markings resembling the foliage of *Pinus*, Mant. R.[1]

Spongida.

Cephalites longitudinalis, T. Smith. R.
Pharetrospongia Strahani, Sollas. R.
Plinthosella squamosa, v. Zitt. C.
Plocoscyphia convoluta, T. Smith. C.
,, sp. C.
Porosphæra globularis, Phill. C.
,, *inciformis*, v. Hag. C.
,, *patelliformis*, Hinde. R.

Actinozoa.

Parasmilia centralis, Mant. R.
,, *granulata*, Dunc. R.

Echinoidea.

Cidaris hirudo, Sorig. (spine). R.
,, *perornata*, Forbes (spine). R.
Cyphosoma Koenigi, Mant. (spine). R.
Echinocorys scutatus, Leske.
,, ,, var. *pyramidatus*, Portl. C.
,, ,, var. *striatus*, Lam. R.
Galerites globulus, Desor. R.
Micraster cor-anguinum, Leske. R.

Crinoidea and Asteroidea.

Asteroidea (marginal ossicles). C.
Bourgueticrinus ellipticus, Miller. R.
,, sp. (nipple-shaped). R.
Marsupites testudinarius, Mill. C.
Uintacrinus sp. C.

Annelida.

Serpula ampullacea, Sow. R.
,, *turbinella*, Sow. C.

Crustacea.

Bairdia subdeltoidea, Münst.
Pollicipes glaber, Roem. R.
Scalpellum maximum, Sow. R.

Polyzoa.

Actinopora papyracea, d'Orb.
Berenicea polystoma, Roem.
,, *regularis*, d'Orb., var. *elliptica*, Greg.
Eschara Lamarcki, Hag.
Proboscina radiolitorum, d'Orb.
,, *anomala*, Reuss.
Stomatopora granulata, Milne Ed.
Spinipora Diconi.

Brachiopoda.

Kingena lima, Defr. R.
Rhynchonella plicatilis, Sow. R.
Terebratulina Rowei, Kitchin. R
,, *striata*, Dav.

Lamellibranchiata.

Exogyra sp.
Inoceramus Cuvieri, Sow. C.
Ostrea vesicularis, Sow. C.
,, *Wegmanniana*, d'Orb. C.
Pecten cretosus, Defr. R.
Plicatula sigillina, Woodw.
Spondylus latus, Sow. R.
,, *spinosus*, Sow. C.

Gasteropoda.

Hipponyx Diconi, Desh. R.

Cephalopoda.

Ammonites leptophyllus, Sharpe. R.
Actinocamax granulatus, Blainv.
,, *verus*, Miller. R.

Pisces.

Corax falcatus, Ag.
Enchodus sp.
Lamna ?

Notes on the Fossils.

Plantæ.—The only plant-remains found belong to the species figured by Mantell as resembling the leaves of *Pinus* (Geology of Sussex, 1822, p. 157, pl. ix, figs. 2, 12). I am not aware that they have been properly described and named. They were found at the north end of the road section.

Spongida.—Siliceous sponges are very abundant, and there appears to be a band of the rock filled with their remains. Their skeletons

[1] R. = rare; C. = common.

are now replaced by iron peroxide, and consequently they are in bad preservation. In addition to the species recognized, there are fragments of Tetractinellid, Lithistid, and Hexactinellid forms, but too imperfect even for generic identification. Calcisponges are not so common, but are better preserved. *Porosphæra* is represented by specimens from 2 to 18 mm. in diameter.

Echinoidea.—*Echinocorys scutatus*, var. *pyramidatus*, is the predominant sea-urchin, and it occurs throughout the section, but more abundantly in association with *Marsupites*. The large depressed or dome-shaped form of *E. scutatus*, the var. *striatus*, is less common. *Micraster cor-anguinum* occurs at both ends of the section, but it is somewhat rare. *Galerites globulus* is rare, and I have only met with it near the south end of the trench. *Galerites albogalerus* (=*conicus*) does not seem to be present in the road section, though it is not uncommon in the Chalk of a road cutting a little further to the south of the present one.

Asteroidea.—The detached marginal ossicles of this group are present in all parts of the section, and they probably belong to several species.

Bourgeticrinus ellipticus.—The cylindrical and barrel-shaped stem-joints are frequent; usually single, but occasionally two are connected together; the heads of this species are rare. The peculiar nipple-shaped heads of another species of *Bourgeticrinus*, figured by Dr. Rowe,[1] but apparently not yet named, are occasionally found. Dr. Rowe states that he has not found this form outside the *Marsupites*-zone.

Marsupites testudinarius.—Detached plates of the test occur in various parts of the road section; they are fairly numerous at the higher south end between the Keeper's House and the end of the trench, and also near the north or Beddington end, below the New Barn Farm, whilst in some of the intermediate portions, where *Uintacrinus* plates are abundant, I have failed to find any of *Marsupites*. No complete specimens have as yet been discovered in this Chalk, but not unfrequently several plates occur in close proximity, as if they had belonged to a single individual. There are notable differences in the size and ornamentation of the plates from different parts of the section; thus, at the south end the plates are large and thick, reaching a maximum of 32 mm. in width, and, as a rule, they are strongly ribbed or striated, whilst those met with at the northern end are relatively thin and not over 14 mm. in width, and their upper surfaces are quite smooth, with occasionally a low fold near the margins. The brachial joints of *Marsupites* are rare, they are considerably larger than those of *Uintacrinus*, and they differ also in form and in the ornamented exterior surface.

Uintacrinus sp.—The irregularly polygonal plates of the test are fairly numerous, more particularly in those parts of the road section between the Keeper's House and the New Barn Farm, where *Marsupites* seems rare or absent. Only single detached plates are

[1] Proc. Geol. Assoc., vol. xvi (1900), p. 297, pl. viii, fig. 6.

found; they range from 4 to 10 mm. in width. The horseshoe-shaped brachial plates or joints are, as one may suppose, more abundant than the test-plates; in some cases several occur in a series as if belonging to the same arm; they range from 2 to 6 mm. in width. Some of these small brachial joints closely resemble those of *U. socialis*, Grinnell, from the Chalk of Kansas, as figured by Dr. Bather,[1] and others correspond as closely with those of *U. Westfalicus*, Schl., from Recklinghausen, in Westphalia, as shown in Schlüter's figures.[2] Whether the forms in our English Chalk belong to either of the above or to a distinct species is, at present, an open question.

Polyzoa.—In addition to the species named in the list, which have been determined by Mr. W. D. Lang, there are several species of Cheilostomata not yet worked out.

Brachiopoda.—This group is very poorly represented in the Beddington section; I have only seen single examples of each of the four species in the list.

Lamellibranchiata.—These are more numerous than the Brachiopods. *Inoceramus* is common in places, and large but imperfect examples occur; small forms of *Ostrea* are distributed generally. *Spondylus spinosus* is not infrequent, and large, well-preserved specimens are met with.

Ammonites leptophyllus is represented by an impression, on a block of chalk, of a portion of the septal sutures of an individual which, in Mr. Crick's opinion, may have been from 2 to 3 feet in diameter, corresponding with those present in the *Marsupites* zone near Margate. It was found at the southern end of the road section near the Keeper's House.

Actinocamax verus.—I only obtained a fragmentary specimen, which was determined by Mr. Crick. It came from near the New Barn Farm, about midway in the road section, where *Uintacrinus* plates are abundant. Two specimens of *A. granulatus* were found by Mr. W. M. Holmes at the higher south end of the trench.

Pisces.—In addition to the teeth named in the list, the Chalk throughout this road section contains great numbers of the scales and bones of small fishes, and one can hardly break up a block without meeting with them, either scattered singly or in small groups of irregularly commingled and compressed bones and scales, without showing any definite outlines of the fish to which they belonged. The fishes were evidently small, and, judging from the number of their remains, they must have swarmed in the sea of the period.

The fossils present in this Plough Lane road cutting prove unmistakably that the Chalk in this part of Beddington belongs to the zone of *Marsupites* and that the *Uintacrinus* band is also well represented. It may also reasonably be inferred that this zone will be found on the same line of strike in South Croydon, where indeed

[1] Proc. Zool. Soc., 1895, pl. liv, figs. 2–13.
[2] Zeitschr. deutsch. geol. Ges., xxx (1878), pl. iv.

its presence has already been anticipated.[1] There appears to be a very close resemblance in the characters of this zone at Beddington and those of the corresponding zone in the coast sections near Margate, so well described by Dr. Rowe.[2] With hardly an exception the same characteristic fossils enumerated by Dr. Rowe and a definite sponge bed are present in both.

Hitherto the highest Chalk in this part of the county has been considered to belong to the zone of *Micraster cor-anguinum*, and in the third volume on the Cretaceous Rocks of Britain, lately issued, it is stated (p. 179) that in the eastern part of Surrey the zone of *Marsupites* is either concealed beneath the Eocene or more probably was removed from the summit of a low anticlinal flexure, formed and eroded before the deposition of the Tertiaries.[3] Professor Barrois included the Purley beds of Caleb Evans in the zone of *Marsupites*, but no specimens of this crinoid have ever been found in them, and it is probable that there is a considerable thickness of Chalk between them and the Chalk of the Beddington ridge in which this fossil abounds.

IV.—The Penzance Earthquake of March 3, 1904.

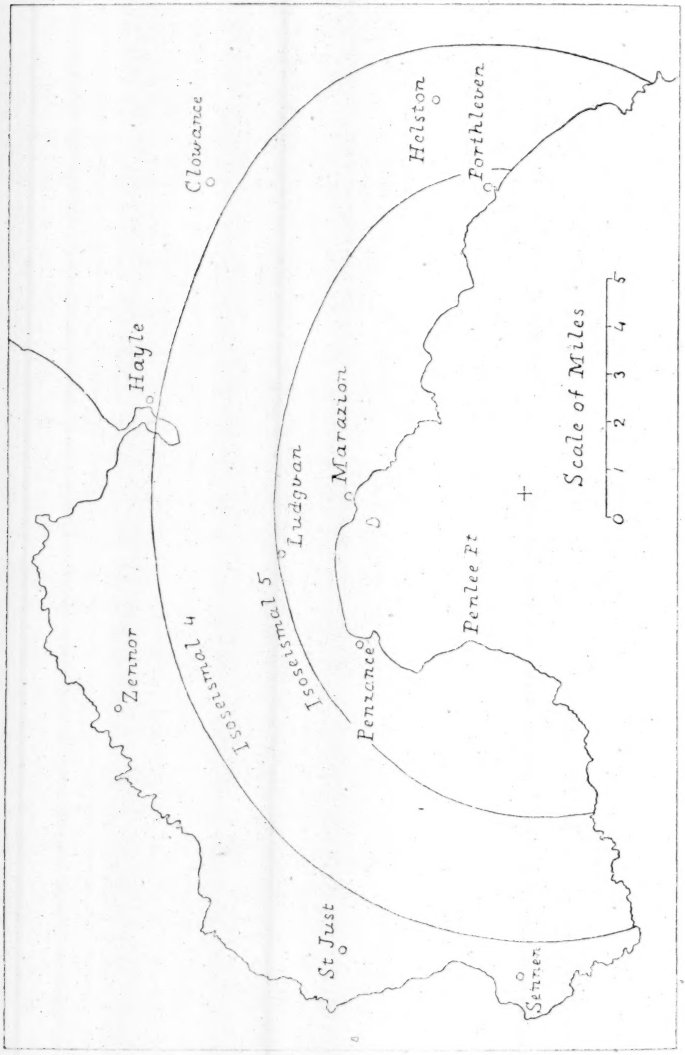
By Charles Davison, Sc.D., F.G.S.

DURING the last fifteen years slight earthquakes have occurred in Cornwall on eight occasions, the dates being Oct. 7, 1889; Mar. 26, 1891; May 16 and 17, 1892; Jan. 26, 1896; and Mar. 29, April 1 and 2, 1898. The Pembroke earthquakes of Aug. 18, 1892 (0.24 and 1.40 a.m.), and Nov. 2, 1893, and the Hereford earthquake of Dec. 17, 1896, were also felt in the county. Local earth-shakes, probably connected with mining operations, occur occasionally, as on June 4 and 10, 1902. Under the same heading should perhaps be included the shock of Aug. 27, 1895, near Blisland, which I was led to class as seismic on account of its very elongated, though small, disturbed area.[4]

The Penzance earthquake of March 3, 1904, occurred at about 1.5 p.m.[5] Isoseismal lines of intensities 5 and 4 are represented on the accompanying map, and these show at a glance that the epicentre was submarine. Little more than half of each curve traverses the land, and the form of the remaining portions over the sea-area can only be conjectured from their trend before leaving the land. If, however, the isoseismal 5 be completed, the centre of the curve must be close to a point (indicated by a cross on the map) in lat. 50° 4·2′ N., long. 5° 27·6′ W., or about 3½ miles south of Marazion. This curve is 13½ miles long, and probably 10 miles

[1] Journ. Roy. Micros. Soc., 1904, p. 7.
[2] Proc. Geol. Assoc., vol. xvi (1900), pp. 294–301.
[3] Terrain crétacé supérieur de l'Angleterre et de l'Irlande, 1876, p. 139.
[4] Geol. Mag., Dec. IV, Vol. VII (1900), pp. 164–5.
[5] The following account is based on 76 records from 16 places, and 13 negative records from 12 places. The cost of the inquiry was defrayed from a grant received from the Government Research Fund.

wide and 110 square miles in area. The isoseismal 4 is 19 miles long, about $15\frac{1}{2}$ miles wide, and 230 square miles in area, its distance from the preceding isoseismal towards the north being $2\frac{1}{2}$ miles. The longer axes of the isoseismals are directed from



Map of Earthquake-area near Penzance, Cornwall.

a few degrees north of east to a few degrees south of west. The earthquake was also observed at a few places outside the isoseismal 4, the sound being heard at Clowance, Sennen, St. Just-in-Penwith,

and Zennor, which are respectively $\frac{1}{2}$, $\frac{3}{4}$, 1, and $1\frac{1}{2}$ miles from the curve, and a slight shock being also felt at Clowance, Sennen, and Zennor.

The shock consisted of a single series of vibrations, which gradually increased in intensity and then faded away, the average of 11 estimates of the duration being about 4 seconds. The sound, as is usual in slight earthquakes, was heard by all the observers. In 18 per cent. of the descriptions it is compared to passing vehicles, in 22 per cent. to thunder, in 2 to wind, in 3 to the fall of a load of stones, in 2 to the fall of a heavy body, in 52 to explosions or the firing of a heavy gun, and in 2 per cent. to miscellaneous sounds. Thus, in 58 per cent. of the records, the type of comparison employed is one of short duration. The beginning of the sound preceded that of the shock in 53 per cent. of the records, coincided with it in 43, and followed it in 4 per cent.; while the end of the sound preceded that of the shock in 2 per cent. of the records, coincided with it in 74, and followed it in 24 per cent. The duration of the sound was greater than that of the shock in 58 per cent. of the records, and equal to it in 42 per cent.

From the above account, it will be seen that the disturbance possesses some resemblance to those which are either wholly or partially artificial in their origin. In particular, the brevity of the sound, as shown by the frequent comparison to explosions of various kinds, is suggestive of heavy gun-firing from a ship about three or four miles south of Marazion. Several correspondents, however, state that no battleships were in the bay on March 3; and I am indebted to the Secretary of the Admiralty for the information that "there is no record of any firing having occurred in that locality on the day in question."

Nor can the disturbance be connected with a fault-slip precipitated by mining operations. For though, as Mr. Clement Reid kindly informs me, there are old workings under the sea near Marazion, Penzance, and Penlee, none of these is in the required position. And, moreover, the isoseismals are farther apart, and the disturbed area larger, than is usually the case with such an origin.

It may therefore be concluded, I think, that the observed phenomena were not due to artificial causes, but rather to a slip, three or four miles in length, along a submarine fault about $3\frac{1}{2}$ miles south of Marazion. In several ways — especially in the small disturbed area, the closeness of the isoseismals, and the brevity of the sound — the Penzance earthquake resembles an after-shock of a moderately strong earthquake, and it is probable that the focus was situated at no great depth. The exact direction of the earthquake-fault is somewhat uncertain, owing to the incompleteness of the isoseismals; but it cannot have deviated widely from that of the lodes in the neighbourhood of Marazion.

In an interesting paper,[1] Mr. Clement Reid has suggested that an

[1] "On the probable occurrence of an Eocene outlier off the Cornish Coast": Quart. Journ. Geol. Soc., vol. lx (1904), pp. 113–117.

Eocene basin may lie under the sea in Mount's Bay and the western part of the English Channel. It is by no means impossible that the last of the series of movements resulting in the formation of the suggested basin was that which caused the recent Penzance earthquake.

V.—Note on two Cephalopods obtained by Lieut.-Col. Skinner, R.A.M.C., from the Valley of the Tochi River on the North-West Frontier of India.

By G. C. Crick, F.G.S., of the British Museum (Natural History).

THE valley of the Tochi River is an outlying corner of the British Empire in India forming a portion of Waziristan, the boundary of which was delineated in 1894–5 by an Anglo-Afghan Commission from the Afghan provinces of Khost on the north and Birmul on the west.[1] Mr. F. H. Smith, of the Geological Survey of India, accompanied this Commission as geologist, and his observations "On the Geology of the Tochi Valley" were published in 1895 in the "Records of the Geological Survey of India" (vol. xxxviii, pt. 3, pp. 106–110, pl. iii). On p. 109 he says:—"The range of hills between Idak and Mirán Shah[2] is formed by an anticlinal ridge which approximately strikes north and south, and which is composed of these lower eocene beds. In the core of the anticlinal a considerable thickness of massive dark grey limestone is exposed, in which I could find no fossil remains; the age of this limestone is therefore doubtful, and there is no evidence of any kind to show whether it belongs to the lowest tertiary or upper mesozoic age."

In 1897 the Tochi Valley was visited by an expedition sent there to avenge an assault upon our troops that was made at Maizar in June of that year by the Madda Khel, a section of the tribe of the Darwesh Khel Waziris who inhabit the locality. Major (now Lieut.-Col.) B. M. Skinner, R.A.M.C., who accompanied this expedition, was fortunate enough to obtain from the anticlinal ridge referred to by Mr. Smith, besides several fragments of coral, the two Cephalopods (an Ammonoid and a Belemnite) which form the subject of the present note.

The information accompanying the Ammonoid (No. 213) is as follows:—"Derived: found in the Alveolina limestone at Mirám Shah, E. of Dandi plain"; whilst the locality of the Belemnite (No. 225) is recorded as "E. of Mirám Shah, halfway to Idak." The portion of Mr. Smith's section referring to this locality is reproduced in the accompanying figure, and Lieut.-Col. Skinner has been so good as to indicate on the section the localities of his fossils. The fragments of coral were found at the spot marked *a*; the Ammonoid was obtained from the débris in the neighbourhood of the limestone at *b*; whilst the Belemnite was found *in situ* at the point marked *d*. At the spot marked *c* Lieut.-Col. Skinner tells me that he observed in

[1] See Major (now Lieut.-Col.) B. M. Skinner, R.A.M.C., "The Valley of the Tochi River," *Science Gossip*, November, 1899, pp. 163–4.

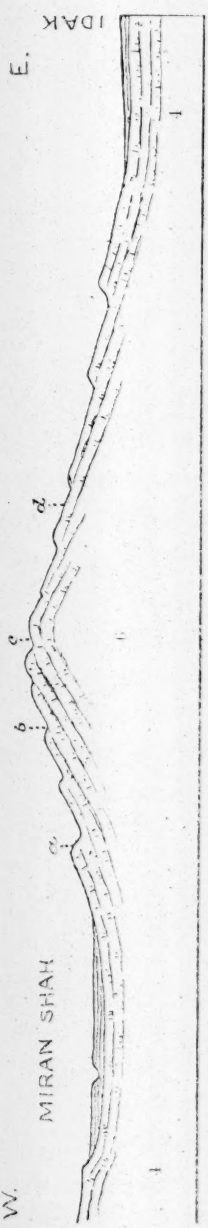
[2] Also spelt Mirám Shah.

the rock a huge branching coral which it was quite impossible for him to extract.

Although the fossils are very fragmentary and difficult satisfactorily to determine, they are of great importance as showing the Mesozoic age of the rocks forming the core of the anticlinal between Mirám Shah and Idak.

The Belemnite (see Text-figure 1, p. 492) is partially imbedded in a light greenish-grey, in places buff-coloured limestone, and its exposed surface has been very much weathered. It was found *in situ* at a spot which Lieut.-Colonel Skinner describes as "E. of Mirám Shah, halfway to Idak," and which is marked *d* on the section reproduced herewith. The specimen is about 47 mm. long, but has been broken across, and the two parts, 20 and 27 mm. long respectively, have been so dislocated that they are now some 5 or 6 mm. apart. The smaller fragment is part of the alveolar end, a portion of the alveolus being preserved. The exposed surface of the fossil is ventral. The ventral surface of the alveolar portion of the guard appears to have been provided with a median groove, but precisely how far this extended backward cannot be ascertained on account of the eroded state of the fossil; it was probably confined to the alveolar region. The guard, as now preserved, is nearly circular in cross-section, its dorso-ventral and transverse diameters being each about 9 mm.; allowing for the erosion of the ventral surface, the guard seems originally to have been a little compressed and nearly cylindrical or possibly a little fusiform. Unfortunately the posterior part of the guard is wanting. The specimen is also so much eroded that a definite determination is quite impossible.

The fragment of an Ammonoid (see Text-figs. 2*a*–*d*, p. 492) consists of the posterior part of the body-chamber. Lieut.-Col. Skinner's note respecting it is as follows:—"Derived, found in the Alveolina limestone at Mirám Shah, E. of Dandi plain." It was found in the débris in the



Section from Idak to Mirán Shah. 4, 4, Middle and Lower Nummulitic beds; 6, Mesozoic (?) Limestone.
(After F. H. Smith, Records Geol. Survey India, vol. xxviii, pt. 3, 1895, pl. iii.)

neighbourhood of the limestone at the locality marked *b* in the section reproduced herewith. Its greatest length is 44 mm.; it is depressed, subtrapezoidal in cross-section, and has its greatest width near the margin of the periphery: its dorso-ventral diameter (or height of the whorl) is 24·5 mm., its greatest width being 34 mm. including the ribs, or 32 mm. excluding the ribs. Although considerably eroded the specimen appears to be not quite symmetrical, one margin of the periphery being much more angular than the other; consequently on one side the most prominent part of the whorl appears to be close to the peripheral margin, whilst on the other the most prominent part is at about one-third of the height of the whorl from the periphery.

The shell was almost entirely evolute, and was scarcely impressed by the preceding whorl; the sides of the whorl are convex, sloping

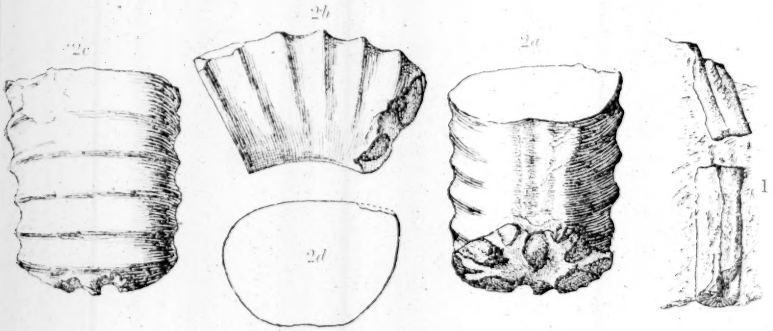


Fig. 1.—Belemnite from Mesozoic rocks (Neocomian?) between Mirám Shah and Idak, Tochi River District, N.W. India. The fissure traversing the specimen longitudinally is of the nature of a crack and not a groove. Drawn from the specimen [register number C. 9296] in the British Museum (Natural History).

Fig. 2.—Ammonoid (*Crioceras*?) from Mesozoic rocks (Neocomian?) between Mirám Shah and Idak, Tochi River District, N.W. India. *a*, peripheral or ventral aspect; *b*, lateral aspect; *c*, dorsal aspect; *d*, transverse section showing asymmetry of the whorl. Drawn from the specimen [register number C. 9297] in the British Museum (Natural History).

gradually from near the margin of the periphery into the umbilicus, the umbilical margin being imperfectly defined. The fragment bears six rather coarse prominent ribs, each about 2 mm. wide, separated by interspaces of about twice their own width. The ribs rise at the inner third of the lateral area, extend rather obliquely forward to the margin of the broad periphery, which they traverse in a straight course without interruption or bifurcation, or apparently without any flattening. The base of the body-chamber is preserved, and, though imperfect, gives the general form of the septal surface and of the suture-line. The septal surface is a little asymmetrical; when the surface is viewed posteriorly the siphonal lobe is seen to be a little to the left of the median line.

The affinities of the fossil are obscure; they seem to be with some forms of the comprehensive 'genus' *Crioceras*, but compared with such Neocomian forms as *Crioceras aegoceras*, v. Koenen,[1] and *C. capricornu* (Roemer),[2] which bear simple prominent ribs, the present specimen has broader, more depressed whorls, and more forwardly-inclined ribs than either of these species. It bears a resemblance to some forms of the Upper Jurassic genus *Simoceras*, but in that genus the transverse section of the whorl is more compressed, whilst the ribs on the peripheral area are strongly curved forward, and the form of its septal surface is different. The last-mentioned character suggests affinity with the Lower Cretaceous forms of *Douvilléiceras* (*D. mammillatum*, *D. Martinianum*, etc.). On the whole we are inclined to refer the specimen to the 'genus' *Crioceras* with a query.

As the two Cephalopods were not found at the same spot and under the same conditions (the Belemnite being obtained *in situ*, whilst the Ammonoid was picked up in débris on the surface of the ground), it is quite possible that they are not of the same age geologically, although their lithological character leads one to infer that such is the case. They indicate, however, the existence of Mesozoic rocks, possibly of Neocomian age, in the anticlinal between Mirám Shah and Idak; and now that the existence of fossils in this limestone has been recorded it is to be hoped that at some future time other specimens may be obtained which will enable the exact age of these rocks to be determined. In conclusion, it may be stated that the fossils referred to in this note have been presented to the British Museum (Natural History).

VI.—The Dolomites of Eastern Iowa.

By Nicholas Knight.

THE experimental work of this investigation was done by Grace D. Bradshaw in the chemical laboratory of Cornell College. The purpose was to determine whether the silica exists in a free condition or is in the form of a silicate; also to ascertain whether the iron is in the ferrous condition as carbonate or is in the form of ferric oxide. The rocks abound in many parts of Iowa, and belong to the Niagara formation. The stratified character even in a small section is apparent, and the layers differ somewhat in composition, as shown by the varying amounts of iron visible in different portions. The rocks are used as building stone to manufacture quicklime and in MacAdam paving.

1. To answer the first question as to the condition of the silica six pairs of determinations were made as follows:—

(*a*) A gram of the finely powdered rock was placed in a small beaker and covered with a watch-glass, a small quantity of dilute hydrochloric acid was added, and the carbonates were dissolved by

[1] Abhandl. d. k. Preuss. Geol. Landesanst., etc., Neue Folge, Heft 24 (1902), p. 328, pl. xxxvi.

[2] Ibid., p. 316, pl. xvi, figs. 1–4.

carefully heating to the boiling-point. The insoluble portion, which is the silica, was filtered off, dried in an air-bath, and the weight determined.

(*b*) A gram of the fine powder placed in a porcelain evaporating dish of 100 c.c. capacity was treated with dilute hydrochloric acid and covered with a watch-glass. It was warmed on the water-bath until there was no further evolution of carbon dioxide. The watch-glass was removed, and the dish was kept on the water-bath until crystals began to appear. As the drying continued the substance was constantly stirred with a glass rod, until a fine dry powder resulted. The powder was next moistened with a few drops of concentrated hydrochloric acid and 20 c.c. dilute hydrochloric acid (equal parts concentrated hydrochloric acid and water), and about the same quantity of water was added. The contents of the dish were then filtered and the silica determined.

The results for the two methods were as follows :—

(*a*)	(*b*)
0·78 per cent.	0·75 per cent.
0·76 ,,	0·90 ,,
0·81 ,,	0·85 ,,
0·87 ,,	0·91 ,,
0·94 ,,	0·87 ,,
0·94 ,,	0·73 ,,

The treatment described under (*b*) would decompose a silicate, while the method under (*a*) would not. As the two series of results are fairly concordant, the conclusion is that the silica exists as a fine sand disseminated through the rock. A private communication from W. H. Norton, of the Cornell College department of geology, states that he came to the same conclusion while studying the rock with a petrological microscope. The method described under (*a*) is simpler than (*b*), and the work can be done in a much shorter time. It is therefore to be preferred in the analysis of rock of this kind.

2. The condition of the iron. A gram of the substance was introduced into a flask of 120 c.c. capacity, fitted with a bulb tube and Bunsen valve to prevent oxidation of the iron. It was dissolved in dilute hydrochloric acid. A few drops of the cooled solution were then withdrawn with a capillary tube, placed on a watch-glass, and tested with a crystal of potassium ferricyanide. No suggestion of a blue colour resulted, showing the iron to be in the ferric condition. This increases the value of a rock as a building material, as ferrous carbonate is an unstable substance with a tendency to change to the ferric condition. A complete analysis of the specimen resulted as follows :—

$CaCO_3$	53·62 per cent.
$MgCO_3$	44·96
SiO_2	0·83
Al_2O_3	0·25
Fe_2O_3	0·34
	100·00

The specimen is nearly a true dolomite, which contains 54·35 per cent. $CaCO_3$ and 45·65 per cent. $MgCO_3$. This method of

analysis was employed:—After removing the silica according to (*a*) a grain or two of pure ammonium chloride is added to the filtrate to prevent the precipitation of magnesium. It is then heated to boiling, and a small excess of ammonia added, which precipitates iron and alumina. They are determined together, and then dissolved in the crucible with warm dilute hydrochloric acid. The solution is treated with caustic potash, which precipitates the iron and dissolves the alumina. The iron is filtered off and discarded, because it cannot be thoroughly washed from the caustic potash. The filtrate is slightly acidified with hydrochloric acid, and the alumina is precipitated with freshly prepared ammonium sulphide. The aluminum sulphide, when heated in a crucible, becomes Al_2O_3. The filtrate from the iron and alumina, containing the calcium and magnesium, was heated to boiling and precipitated with a $\frac{N}{4}$ solution of ammonium oxalate, care being used to avoid much excess of the reagent. The precipitate was allowed to stand eight or twelve hours before filtering. The well-washed precipitate of calcium oxalate, containing also a small quantity of magnesium oxalate, was dissolved in warm, dilute hydrochloric acid, and the solution was made alkaline with ammonia. This precipitates the calcium oxalate, and leaves the magnesium in solution. This with the main portion of the magnesium is precipitated as magnesium-ammonium phosphate, and weighed as magnesium pyrophosphate.

VII.—On the Cause of Compression of the Earth's Crust.[1]

By the Rev. O. Fisher, M.A., F.G.S.

I USED to think that the corrugations of the earth's crust were due to compression through the shrinking of the interior. To judge of the sufficiency of this cause the first thing to be done is to seek a measure of the compression, and then to compare the result of the effects of cooling with the actual amount of compression. The most satisfactory measure appears to be the thickness of the layer which the corrugations would form if levelled down. The question then becomes one of *how much*. In 1863 Lord Kelvin (then Sir W. Thomson) formulated a law of secular cooling upon the hypothesis that the interior is solid. Adopting a probable value for the contraction of rocks in cooling, I calculated the thickness of the layer which would be produced by the corrugations resulting, and found it far short of that which the existing inequalities would form if levelled down. Mr. Mellard Reade and Dr. Davison subsequently discovered the existence of a level of no strain within the crust, and this greatly reduces the possible amount of corrugations. The conclusion at which I arrived was that, on the hypothesis of a solid globe, secular contraction through cooling would not account for the corrugations.

Numerous phenomena suggest to the vulcanologist that the substratum is a liquid magma holding water-gas in solution. The free

[1] Read before the British Association, Cambridge, Section C (Geology), Aug., 1904.

yielding of the substratum is also testified by the phenomena of isostacy. I have therefore endeavoured to estimate the amount of corrugations which would be produced by a cooling globe also on this hypothesis. But although they would be slightly greater than in the case of a solid globe, they still fall far short of those actually existing. I therefore argue that the corrugations of the crust are not due to the shrinking of the interior away from the cooled crust, whether we regard the interior as solid or liquid.

If it be asked what my views are upon this vexed question, I may be allowed to say that I have published them fully in my "Physics of the Earth's Crust." In it I have given reasons for believing that the substratum is affected by convection currents, and that these *ascend* beneath the oceans, and flowing horizontally towards and beneath the continents, and descending beneath mountain chains, are the cause of the compression of the crust, and other disturbances, of which we are in search.

Before giving my reasons for believing that upward convection currents exist beneath oceans, it is in the first place necessary to combat the dictum of leading physicists that the interior of the earth is solid. It has been asserted that, unless the earth is extremely rigid, bodily tides would be produced, and that there would be no rise and fall of the water relatively to the land. If the earth was a smooth spheroid covered with a uniformly deep ocean this would no doubt be true. But as matters stand, the tides of short period are affected by local irregularities known as the establishment of the port. If the substratum of the crust is liquid, isostacy requires large protuberances of its underside, which would cause irregularities in the tides in the magma analogous to those in the ocean, and, unless these agree in time, in height, and in place, with the water tides, the latter will not be obscured by them, and may even be augmented.

Of tides of long period the fortnightly is the most important; but I think I have shown in the Appendix to my "Physics of the Earth's Crust" that it had not been proved by fifteen years of observation that any such tide existed,[1] which would be an argument in favour of the liquidity of the interior.

The peculiarities of the transmission of earthquake waves to great distances through the body of the earth have been appealed to, as approving to all, "except some geologists,"[2] that the earth is solid. The disturbance first arrives as a series of minute tremors. These have been considered to be waves of compression. They are soon followed by somewhat larger disturbances, which have been considered to be waves of distortion. Since waves of distortion could not be propagated in a liquid, it is maintained that the earth is hereby proved to be solid. In reply to this argument I have shown that, if a liquid magma holds gas in solution, two types of waves will be propagated through it with different velocities. Tremors will first arrive due to the compressibility of the magma, and subsequently waves caused by the extrusion of gaseous vesicles due

[1] p. 34.

[2] Darwin's "Tides," p. 236.

to the changes of pressure. If my argument is valid, that for solidity loses its force.[1]

I will now give my reasons for thinking that the substratum, if a liquid, is not a still liquid, but is affected by convection currents.

Availing myself of Sir Arthur Rücker's observed values of the melting temperature and specific heat of Rowley rag, I have calculated that, if the substratum of the crust be a still liquid, the thickness of the crust comes out 22 miles, and the corresponding time since it began to solidify about eight million years. This is a much shorter time than geologists would admit. This result proves that the substratum is not a still liquid, and must therefore be affected by convection currents, bringing up heat from below and delaying the thickening of the crust. The existence of convection currents being thus, as I submit, established, I will add my reason for believing that they ascend beneath the oceans.

By a somewhat complicated calculation, which, although criticised by Mr. Blake,[2] has been ably defended by Mr. Brill,[3] I have, I think, proved that the substratum beneath the oceans is less dense than beneath the land. This shows that the upward currents are beneath the oceans. I have at the same time proved that the suboceanic crust does not reach quite so deeply down as the continental crust, and that its upper layer is thin and very dense, from which I infer that it consists of basic lava-flows[4] the oxydation of which would afford the red clay, which covers the bottom of the deeper oceans.

These convection currents, ascending beneath the oceans and then flowing horizontally towards and beneath the continents, till they descend, are in my opinion the cause of the compression of the continental crust.

VIII.—The High-level Plateau Gravels on the North Side of the Tamisian Area, and their connexion with the Tertiary History of Central England.[5]

By Alexander Irving, B.A., D.Sc.

THE author refers to his work in former years among the High-level Plateau Gravels south of the Thames, chiefly in Berks and Surrey, the results of which were given in various papers from ten to twenty years ago.[6] The present note may serve as a supplement to those papers, in which the conclusion was arrived at that the gravels in question were to be regarded as distinctly of riverine origin and, upon the whole, of Pliocene age. Occupying original

[1] Proc. Camb. Phil. Soc., 1904.
[2] Phil. Mag., 1894.
[3] Ibid., 1895.
[4] "Physics of the Earth's Crust," Appendix, p. 8.
[5] A paper read before the British Association, Cambridge, Section C (Geology), August, 1904.
[6] "The Bagshot Strata and their Associated Gravels," Proc. Geol. Assoc., vol. viii (1883); "On the High Level or Plateau Gravels," Quart. Journ. Geol. Soc., vol. xlvi (1890); Lecture at Windsor on "The Geological History of the Thames Valley," *Science Gossip*, May and June, 1891; "On Surface Changes in the London Basin," Geol. Mag., May, 1893.

lines of drainage, they now cap the higher parts of the terrain of the Bagshot country, having preserved those parts from degradation, while the intervening portions have been removed by ordinary agents of denudation to form the present southern upland valley-system of the Thames Basin.

This view, first propounded in 1883, was endorsed by the late Sir Joseph Prestwich, F.R.S., in his papers on the Mundesley and Westleton beds, which were given to the Geological Society in the year 1890. The author is not aware that that view has been seriously combated.[1]

In the present communication the term 'Plateau Gravels' is used in the same sense as in that earlier literature of the subject by the author and other writers. It denotes a series of altogether different age from that denoted by the term as it is used in the Handbook to the Natural History of Cambridgeshire written for the use of members of the British Association at the Cambridge meeting of 1904. They are of pre-Quaternary age, and are overlain by Boulder-clay. They may be regarded as the lower stretches of the series which cap the higher ground of Herts and the adjoining counties, which was doubtless a continuous sloping plateau before the present trough-like valleys, such as those of the Stort and the upper Lea, were incised upon it.[2] The term 'plateau gravel,' therefore, here, as in the case of the other series to the south of the Thames, seems to be appropriate. The gravels themselves repose upon the Tertiary strata of the district. In *structure* and in their relation to the Eocene formations they correspond completely with the high-level plateau-gravels to the south of the Thames, that structure having been minutely described by the author in the papers referred to.[3] But the *composition* of these gravels on the north side is totally different from that of those on the south side of the Thames Valley. There everything points to the derivation of the materials from the once much higher country formed by the Wealden and Kingsclere axes of elevation; here the materials are such as could only have come from the north or north-west. Their most marked characteristic is the abundance of quartzite pebbles, together with quartz, chert, and Lydian stone, from the Bunter of the north and west Midlands. Along with these rolled fragments of Millstone Grit, Coal-measure Sandstone, Carboniferous Limestone, Magnesian Limestone are of less common occurrence, while even pebbles of felstone and gneiss, probably from the Malvern crystallines, may be recognised. All these materials *may* have been derived immediately from the Bunter Sandstone as the author is acquainted with it; and along with these the more durable rocks of the intermediate Jurassic series of the Mercian area are represented, together with Belemnites and Grypheas rolled into pebbles; telling us that the peneplane

[1] This is now generally recognised, yet in a referee's note to the original MS. in 1883 it was pronounced "new to geology and baseless"!

[2] The valley in which Much Hadham lies affords a good example of this trough-like form on a smaller scale.

[3] See especially "Note on the Plateau Gravels, etc.": Q.J.G.S., Nov., 1890.

of the Chalk extension to the north-west, across which these rivers flowed, had been already so deeply furrowed by them that they had even then begun to saw down into the Jurassic rocks. Rolled fragments occur of basic igneous rocks and other crystallines, the origin of which it is not easy to determine, though they may have come from Charnwood or from the igneous intrusions of Warwickshire and Worcestershire. Sarsens and flinty detritus are common enough in the gravels as well as Tertiary flint pebbles.

Not only are these gravels much older than the Boulder-clay (and its equivalents), superimposed upon them, but their relation to the present river-drainage shows that they are older than even the pre-Glacial valleys of erosion in the Chalk, now buried beneath alluvial detritus, which has been proved by a well in the valley of the Stort to a depth of 170 feet; while on the watershed between the Stort and the Cam (also a buried valley) a well-section close to Elsenham Station has proved a depth of 90 feet of drift before the Chalk is reached. We do not know that we have there reached the lowest line of the submerged valley, the original *Thalweg*.

The author regards these plateau gravels as the deposits of Mercian rivers, which flowed through the gaps in the present Chalk range, such as those of Elsenham and Hitchin, towards the ancient arterial Tamisian line of drainage of southern England during the great Miocene elevation of north-western Europe, long before the present escarpment of the Chalk was formed, and therefore before the initiation of the Mercian river-system, as it exists to-day with its convergence towards the Wash and the Humber. In one section at Stansted a fault of five feet throw cuts through the Chalk, the Reading Beds, and the stratified gravels, showing their common participation in later earth-movements, while the Glacial deposits above are unaffected. The author conceives these well-stratified and indurated gravels, splendid examples of which may be seen at Thorley and by the Hallingbury road on the opposite side of the Stort, to be the deposits of a river, at a time when the now buried valleys of the Stort and the Cam in the initiatory stages of their erosion formed perhaps one continuous channel, and before the axial movement took place, which has had much to do with differentiating the present Tamisian and Mercian systems of river-drainage. That movement probably dates from the close of the Miocene period, the corresponding subsidences to the north-west and south-east of the axis of anticlinal flexure being indicated by the ingress of the sea and the consequent Crag deposits in East Anglia on the one side, and by the northerly dip of the strata (with perhaps a true dip to the north-west) as seen in the cliffs at Hunstanton on the other side. This latter subsidence, together with the recession of the Chalk escarpment by denudation, determined probably the present system of drainage towards the Wash in Pliocene times. The nature of the detritus which has buried the ancient Stort Valley is exhibited at the present time in two open gravel-pit sections at Stansted on a magnificent scale, one on either side of the valley, the section in the largest pit showing

a vertical face of forty to fifty feet. The data we possess in the well-sections at Elsenham and Bishop's Stortford show a gradient sloping to the north of less than one degree between those two places, a distance of about five miles; the presumed reversal of drainage of the ancient Cam Valley is therefore comparatively a small matter. The present head-waters of the Cam and the Stort have doubtless been determined by later developments in the configuration of the country.[1] The absence of all traces of Tertiary marine deposits north of the Mercian Chalk escarpment furnishes evidence of the continental elevation of north-western Europe during Miocene time, as mapped by Professor Zittel in his work "Aus der Urzeit."[2] But the physiographical agencies of nature were not suspended; and rivers gathering their head-waters from a much higher gathering-ground to the north-west than exists to-day, with contours of the land over the Mercian area furnishing gradients sufficient to keep their middle courses pretty free from detritus, could not fail to do their work in laying down extensive stretches of shingle on the northern slopes of the ancient Thames Valley, as we see it done in modern times by the floods of the Alpine rivers which debouch upon the plains of Bavaria in their course to join the upper Danube.

Taking all the facts together, and taking into account the further fact that observations of them by the present writer for the last ten years and by other observers has failed to detect any signs of glaciation in these stratified gravels, even on the rolled sarsen blocks included in them, it seems impossible to regard them by any stretch of scientific imagination as 'interglacial.' It will be seen that the author's work has proceeded on lines parallel with that of Dr. A. E. Salter and Mr. Osborne White, and leads to similar results.[3]

The differential earth-movements, which culminated in the Miocene continental elevation, may be traced back even to Eocene time by the abundant evidence that we have of the attenuation, as we work northwards, of the Middle and Lower Bagshot strata. High-level stratified gravels of a type differing from those described here are found, as we get away from the ancient transverse lines of drainage, composed chiefly of redistributed pebbles and sand of the Bagshot beds, of the quondam extension of which northwards we have evidence in a considerable outlier near Sudbury in Suffolk; but with these the present communication is not intended to deal.

This short paper suggested itself as an addendum to the admirable lecture by Dr. J. E. Marr, F.R.S., on the Geology of Cambridgeshire at the meeting of the British Association at Cambridge, dealing, as it does, with a district only a few miles removed from the county boundary, physiographical relations being more important to geologists than such artificial limitations.

[1] Fuller details are given by the present writer in a paper read before the Geologists' Association in 1897 and published in its Proceedings, vol. xv, Feb., 1898.

[2] Published by R. Oldenbourg, of Munich.

[3] See Proc. Geol. Assoc., vol. xiv, Aug., 1896; vol. xv, Aug., 1897.

IX.—On Basic Patches in the Mount Sorrel Granite.

By R. H. Rastall, B.A., F.G.S.

During a visit to Mount Sorrel at the end of last year I collected a number of specimens of the dark-coloured patches which are so common in the granite. I have had about a dozen of these sliced, and an examination of them has yielded some results which seem worthy of a brief description.

These dark patches vary a good deal in character, and may be divided into three fairly well-defined types, as follows :—

(1) Small black or grey, generally angular patches, without porphyritic felspars.

(2) Somewhat larger and usually ovoid patches of a brown colour, generally enclosing felspars of porphyritic habit.

(3) Rather large black bodies, distinctly banded and often penetrated by parallel veins of granite, in the manner usually described as *lit-par-lit* injection. These have an obvious outward resemblance to blocks of banded or bedded rock.

Corresponding to this macroscopic classification are distinct differences in the microscopic structure, and the special character of each type may be shortly described.

Type 1. The patches of this class consist essentially of felspar and hornblende with only a little interstitial quartz. The felspar is usually a plagioclase, in rather narrow lath-shaped sections, of the habit usual in basic intrusive rocks. The hornblende also occurs in small prisms, and is often chloritised; in places it has a distinctly ophitic character. Near the centre of the patch these two minerals, with a very little quartz, make up the whole mass, but towards the outside the crystals become more widely separated and are enclosed in poecilitic fashion in large plates of orthoclase or perthite. These are often continuous with the felspars of the normal granite. It is very noticeable that in such patches the minerals are often much decomposed, forming 'saussurite' chlorite, epidote, and other secondary products, while the normal granite surrounding them is very fresh.

Type 2. Brown patches with large pink felspars. The structure here is very similar to that just described, but more quartz is present; the quartz is interstitial, and in parts has a sort of pseudogranophyric appearance. The large felspars are often much rounded and also show internal zones of corrosion.

In both the black and the brown patches there are often to be seen large crystals of sphene of a very peculiar habit. The sphene is moulded on crystals of felspar, etc., in an interstitial manner, and in a slice numerous disconnected patches extinguish simultaneously over a large area. Sphene of this kind must almost of necessity be of secondary origin.

Another noteworthy point is the almost total absence of biotite in the dark patches, although it is more abundant than hornblende in the normal rock.

This part of the subject may be summed up by saying that both the dark grey and brown patches strongly resemble in their microscopic structure certain altered rocks of the kind commonly described as Diabase, and if taken alone they would be most accurately described as epidiorite.

I have only one slice of the banded type of inclusion, and this differs entirely from those above described. It consists of an aggregate of flakes of strongly pleochroic brown biotite and grains of magnetite, enclosed in poecilitic fashion in large plates of felspar, which at the margin are continuous with the felspars of the normal granite. These plates are of variable character—orthoclase, microcline, or more commonly plagioclase.

This is obviously something very different from the cases before described, and I am inclined to regard it as an altered slate fragment caught up during intrusion, and metamorphosed by the granite.

The foregoing brief descriptions show that these dark patches in all cases possess some of the characters of a metamorphic rock, and it is even possible to form an opinion as to what the original rock may have been. The most promising case is what has been spoken of above as the 'diabase' type. In these the absence of biotite is sufficient to show that they are not mere centres of concentration of the basic molecules of the magma, as they do not consist of the same minerals as the rest of the rock in different proportions. The abundance of secondary sphene is also suggestive.

I therefore conclude that the dark patches in the Mount Sorrel granite are, in all cases yet examined, much altered fragments of other rocks caught up by the magma during intrusion, and I suggest that it is possible to discriminate to a slight extent between those of igneous and of sedimentary origin.

X.—Recent Coast Erosion in Suffolk: Dunwich to Covehithe.

By John Spiller, F.C.S.[1]

THIS communication brings up to date the record of losses on the Suffolk coast, and continues the report presented at the Ipswich Meeting, 1895, of which details were published in the Geological Magazine for January, 1896. Since that time scarcely a year has passed without the winter gales and high tides doing mischief at one or more points of the coast embraced within the above-mentioned limits; but whilst Lowestoft and Pakefield, Covehithe and Easton have all suffered very considerably, the cliffs at Dunwich remained until quite recently almost unaffected.

The losses may be summed up as follows:—

Dunwich.

All Saints Church ruins and graveyard.—The 43 feet of land

[1] Read before the British Association, Cambridge, Section C (Geology), Aug., 1904.

reported by Mr. Whitaker, September, 1880,[1] became 25 feet by the Director's (Dr. Teall's) measurement in August, 1902. Now all gone, and about 6 feet of the northern buttress of the church dropped into the sea. Total loss, 31 feet in two years.

Footpath at Temple Hill.—At same date Mr. Whitaker says, "40 yards outside the wood." The Director in 1902 made it 38 yards, equal to 114 feet. It has now diminished to 59 feet. Actual loss, therefore, 55 feet in two years.

The cliffs extending away north and south have lost more than this except at Misner. The lifeboat at the Coastguard Station cannot be used at present, for much of the shingle beach is gone and the boathouse left perched on a terrace. Ordinary tides reach the foot of the cliffs and further losses may be expected.

Walberswick.

The high shingle beach is cut back all the way from Dunwich to the mouth of the river Blyth.

Southwold.

A good result has followed the lengthening of the old North Pier at the Harbour by 60 feet, a considerable quantity of sand and shingle having been thrown up; but the benefit of this extension does not reach to the Lifeboat House, which is practically useless and barricaded for further protection. It has been suggested that an additional 50 feet might be built on to the pier, and that the old jetty near the centre cliff should be reconstructed with perhaps an intermediate strong groyne. The timber breastwork in front of the town has stood well since it has been continued to Buss Creek and strengthened at critical points by double piling. The new pier, 880 feet long, erected by the Coast Development Company at the North Cliff has acted like a groyne, and vastly increased the width of beach on both sides of it, so that the bathing station threatened with destruction in 1895 is better than ever.

Easton.

The low land extending from Buss Creek to the southern slope of Easton Cliff remains as before protected by a huge bank of shingle, but from this point onward to the Broad great losses have occurred. The site of the gun battery is buried out at sea, with the powder magazine behind it now left in ruins on the shore 50 feet outside the present edge of cliff. The rifle range has been shortened by 100 yards and a new butt constructed, so that the total loss may be estimated at 350 feet since 1895. The effect of this demolition is to bring Covehithe Ness prominently into view, whereas it was formerly almost invisible from Southwold. Another necessary consequence is that the coastline, straight in the Ordnance Map, has once more become curved inwards, corresponding with

[1] See Memoir of the Geological Survey, "Southwold and the Suffolk Coast," by W. Whitaker, F.R.S., p. 48.

the original Sole Bay. The seam of shelly crag at the foot of Easton High Cliff was uncovered a year ago for the length of 40 yards, but is now entirely hidden by masses fallen from the cliff. The measures of loss (nine years) are as follows :—

Easton Cliff, southern end	...	...	...	350 feet.
Roadway, Easton Bavents	...	...	...	163 ,,
Easton High Cliff	...	...	...	77 ,,

Covehithe.

Beyond Easton Broad the cliffs leading to Covehithe are constantly presenting new faces with bright yellow and pink colouring, suggestive of Alum Bay. The losses would probably have been greater but for ledges of hard sand rock projecting some 10 to 12 feet, and acting as benches for the support of the upper strata. At Covehithe roadway, starting from the hedge and cliff barrier, frequent measurements have been taken since 1895, showing gradual diminution in length from 62 yards to a remnant of 19 yards. Total loss in nine years = 129 feet.[1]

XI.—The Glaciation of Holyhead Mountain.

By Edward Greenly, F.G.S.[2]

THE bare and rocky hill known as Holyhead Mountain is of considerable interest in connection with recent geological events, standing as it does some thirty miles out from the highlands of Carnarvonshire into the Irish Sea Basin; and in such remarkable isolation, for it is much the highest of the five hills which rise above the general level of the platform of Anglesey.

Its height is only 721 feet, but so strongly featured is it, especially towards the west, that one feels the term 'mountain' to be no misnomer, and can hardly believe it to be really lower than many of our smooth wolds and downs of Oolite and Chalk. Being composed, moreover, of white quartzite (or more properly of quartzite-schist), and being so bare of vegetation, it recalls much more vividly certain types of scenery in the Scottish Highlands than anything in those Welsh mountains that one sees from its sides. Towards the east it slopes at a moderate angle, but a little west of the summit it is traversed by a very strong feature, due to a fault, running nearly north and south, along which is a line of great crags, facing west, and prolonged northwards into the still greater sea cliffs towards the North Stack. Beyond this the land still remains high, but is smoother in outline, a somewhat softer series of rocks extending from the fault to the South Stack, where the high moors end off in great cliffs above the sea.

[1] The author's communication was illustrated by maps and photographs, and a discussion followed as to the best means of artificial protection.

[2] Read before the British Association, Cambridge, Section C (Geology), Aug., 1904.

The whole mountain is strongly rubbed and *moutonnée* on the north-east side, every boss having the characteristic outline. (The outline of the whole mass, indeed, is like that of a gigantic *roche moutonnée*.) On many of these surfaces, which are often polished and shine in the sun, the hard and enduring quartzite still retains fine striæ, while towards sunset on a summer's evening they can be detected almost everywhere. The rocks of the South Stack series have not retained them so well. The general direction is N.E.–S.W., with local variations and deflections ranging from S. 35° W. to W. 40° S. A more marked deflection is S. 10° W. near the flagstaff above the South Stack. On the South Stack itself they run S.S.W., fanning out to south-west on the slope of the boss. Along the southern slopes of the mountain they tend to west of south-west.

Striæ cross the summit itself running S. 40° W. The ridge at the summit and towards the North Stack falls steeply westward for 50 or 100 feet before breaking into the crag and sea-cliff alluded to above, and at the brow of this vertical cliff the rocks are still polished and traversed by striæ running in the usual N.E.–S.W. direction, in spite of being under the lee of some 50 or 100 feet of steep rock.

Undercut furrows have not been observed on the mountain itself, but it may be worth while to note that they occur at Ffynnon Gorlas, on the lower ground at its eastern foot, where, also, a surface facing south-west and overhanging, as much as 40°, and in one place 60°, from vertical, is rubbed and smoothed.

The mountain proper (excluding the South Stack moors) is very bare of drift, but a little till occurs in the hollows, with débris chiefly from the eastward so far as yet recognized. Many large boulders of the quartzite occur on the South Stack moors.

At the summit are many small fragments of the well-known green mica-schists of the neighbourhood of the town, with other erratics. These schists do not occur *in situ* at a greater elevation than about 220 feet; and in the direction from which the striæ indicate ice-movement, not more than 100 feet. The fragments have therefore been lifted 500 feet at least, and almost certainly 600 feet, during their journey.

Although it has long appeared to me that we have much to learn from research in Arctic and Antarctic lands, and cannot hope yet to be able to explain many of the glacial phenomena of the past, yet a group of facts like these of Holyhead seem to be more easily explained by the passage of land-ice than by any other hypothesis.

The general direction of glaciation, it may be observed, is parallel to that of the mainland of Anglesey so far as I have yet examined it.

In conclusion, there are some banks and mounds on both sides of the mountain, the most marked being on the south-west side, which have much of the appearance of moraines; and are, moreover, so far as I can make out, composed almost exclusively of quartzite débris. It would be interesting if, in spite of the comparatively slight elevation, one or two small local glaciers had lingered, or perhaps for a short time formed, upon this exposed and lonely hill.

NOTICES OF MEMOIRS, ETC.

I.—British Association for the Advancement of Science. Seventy-Fourth Annual Meeting, held at Cambridge, August 18–24th, 1904.

List of Papers read in Section C, Geology.

Aubrey Strahan, F.R.S., President.

President's Address. (See p. 449.)

Dr. J. E. Marr, F.R.S.—The Geology of Cambridgeshire. (See p. 508.)

F. W. Harmer.—The Great Eastern Glacier. (See p. 509.)

W. Whitaker, F.R.S.—On a Great Depth of Drift in the Valley of the Stour, Suffolk. (See p. 511.)

W. Whitaker, F.R.S.—Some Cambridgeshire Wells. (See p. 511.)

H. B. Woodward, F.R.S.—Note on a small Anticline in the Great Oolite Series, north of Bedford. (See p. 439.)

J. Spiller.—Recent Coast Erosion in Suffolk: Dunwich to Covehithe. (See p. 502.)

J. W. Stather.—Report of the Committee on the Drift Deposits at Kirmington, Lincolnshire. (See p. 512.)

Professor W. J. Sollas, F.R.S.—On the Structure of the Silurian Ophiurid *Lapworthura Miltoni*.

Dr. B. N. Peach, F.R.S., and *Dr. J. Horne, F.R.S.*—The Base-line of the Carboniferous System round Edinburgh.

Dr. R. H. Traquair, F.R.S.—Note on the Fish-remains recently collected by the Geological Survey of Scotland at Salisbury Crags, Craigmillar, Clubbiedean Reservoir, and Torduff Reservoir, in the Edinburgh District.

Dr. R. H. Traquair, F.R.S.—On the Fauna of the Upper Old Red Sandstone of the Moray Firth Area.

G. W. Lamplugh.—Note on Lower Cretaceous Phosphatic Beds and their Fauna.

G. W. Lamplugh.—Marine Fossils from Ironstone of Shotover Hill.

E. A. Newell Arber.—On the Fossil Plants of the Upper Culm Measures of Devon.

E. A. Newell Arber.—On derived Plant-petrifactions from Devonshire.

Professor H. G. Seeley, F.R.S.—On Fossil Footprints of Reptiles from the Stormberg Beds of the Karroo of Cape Colony.

Dr. J. E. Marr, F.R.S.—Report of the Committee on Life-Zones in the Carboniferous Rocks.

J. Lomas.—Report of the Committee on the Fauna and Flora of the Trias.

Discussion on the Nature and Origin of Earth Movements, opened by the President, Dr. J. Horne, F.R.S., Professor W. J. Sollas, F.R.S., and Mr. J. J. H. Teall, F.R.S.

Professor P. F. Kendall.—Evidence in the Secondary Rocks of persistent movement in the Charnian Range.

Rev. W. Lower Carter.—River Capture in the Don System.

E. Greenly.—The Glaciation of Holyhead Mountain. (See p. 504.)

Rev. O. Fisher.—On the Elephant-trench at Dewlish, Dorset.

Professor P. F. Kendall.—Report of the Committee on Erratic Blocks.
Professor H. Bäckström.—On the Origin of the Great Iron Ore Deposits of Lappland.
A. Harker, F.R.S.—Exhibition of specimens of Tertiary Plutonic Rocks (including Gneisses) from the Isle of Rum.
E. Greenly.—The Lava-domes of the Eifel.
Professor W. W. Watts, F.R.S.—Report of the Committee on Geological Photographs.
Professor H. A. Miers, F.R.S. — Concretions as the Result of Crystallisation.
R. H. Rastall.—Basic Patches in Mount Sorrel Granite. (See p. 501.)
L. J. Spencer.—On the different modifications of Zircon.
R. H. Solly.—A preliminary description of three new Minerals and some curious Crystals of Blende from the Lengenbach Quarry, Binnenthal.
Professor K. Busz.—On the Granite from Gready, near Luxullian in Cornwall, and on some Contact Rocks.
A. W. Dwerryhouse.—Report of the Committee on Underground Waters of North-West Yorkshire.
Professor P. F. Kendall.—Exhibition of a Model of the Cleveland Area, showing Glacier-lakes.
Rev. W. Lower Carter.—On the Glaciation of the Don and Dearne Valleys.
H. N. Davies.—On the Discovery of Human Remains under Stalagmite in Gough's Cave, Cheddar, Somerset.
Dr. Scharff and *G. W. Lamplugh.*—Report of the Committee to Explore Irish Caves.
J. Parkinson.—The Geology of the Oban Hills, Southern Nigeria.
A. W. Gibb.—On the occurrence of Pebbles of White Chalk in Aberdeenshire Clay.
W. G. Fearnsides and *R. H. Rastall.*—On Boulders from the Cambridge District collected by the Sedgwick Club.
Rev. Dr. Irving.—On Stratified High-level Gravels and their Relation to the Boulder-clay. (See p. 497.)
J. N. Shoolbred.—Tidal Action in the Mersey in Recent Years.
Rev. O. Fisher.—The Cause of Compression of the Earth's Crust. (See p. 495.)

Papers bearing on Geology read in other Sections :—

SECTION D.—ZOOLOGY.

Professor W. B. Scott (Princeton, U.S.A.).—The Hoofed Animals of the Santa Cruz Beds of Patagonia.
Dr. C. W. Andrews. — Egyptian Eocene Vertebrates and their Relationships, particularly with regard to the Geographical Distribution of Allied Forms.
Professor H. F. Osborn (Columbia University, New York).—The Evolution of the Horse.

SECTION E.—GEOGRAPHY.

President's Address (D.W. Freshfield).—On Mountains and Mankind.
Moritz von Déchy.—The Glaciers of the Caucasus.

R. T. Günther.—Changes of Level on the Italian Coasts.
R. H. Yapp.—Vegetation features of the Fen District.
H. Y. Oldham.—Changes in the Fen District.
Dr. Vaughan Cornish.—Report of Committee on Terrestrial Surface Waves.
Dr. Tempest Anderson.—The Lipari Islands and their Volcanoes.
A. W. Andrews.—A Geographical Object-lesson: Passes of the Alps.

SUB-SECTION OF ANTHROPOGRAPHY.

Professor A. MACALISTER, F.R.S., Vice-President, in the Chair.

Dr. Valdemar Schmidt.—The Latest Discoveries in Prehistoric Science in Denmark.
Miss Nina F. Layard.—Further Excavations on a Palæolithic site at Ipswich.
Report.—The Lake-Village at Glastonbury.

SECTION K.—BOTANY.

FRANCIS DARWIN, M.A., M.B., F.R.S., President.

Dr. D. H. Scott, F.R.S.—A New Type of Sphenophyllaceous Cone from the Lower Coal-measures.
Dr. D. H. Scott, F.R.S., and *E. A. Newell Arber.*—On some New Lagenostomas.
E. A. Newell Arber.—A new feature in the Morphology of the Fern-like fossil *Glossopteris*.
Francis J. Lewis.—Interglacial and Post-Glacial Plant Remains from the Peat of England and Scotland.
Dr. D. H. Scott, F.R.S.—Semi-popular Address on a New Aspect of the Carboniferous Flora.

II.—THE GEOLOGY OF CAMBRIDGESHIRE. By J. E. MARR, Sc.D., F.R.S., Pres. Geol. Soc.[1]

THE main physical features of the county are the Chalk uplands of the south-eastern and southern part, the curious plateau on the west, the Cam Valley between them, and the fenland of the north.

Of Jurassic rocks, the Oxford Clay is not well exposed save near Whittlesea. The Corallian rocks are of considerable interest. Two types occur—the Ampthill Clay facies of the western outcrop and the Calcareous facies of the Upware Inlier. The Elsworth rock forms the base of the deposits of each of these types, and its relationship to the members of the Calcareous facies is a subject still under discussion. The Upper and Lower Kimeridge Clay are found at Ely and in the neighbourhood of that city.

Of Cretaceous rocks the Lower Greensand is well seen near Gamlingay. The old phosphate workings of Wicken are now closed. The Gault is seen in many exposures. Most of the sections exhibit Lower Gault, but Mr. Fearnsides has recently detected the Upper Gault in the Barnwell brick-pit. The basal member of the Chalk,

[1] Abstract of paper read before the British Association, Cambridge, Section C (Geology), August, 1904.

the well-known Cambridge Greensand phosphatic seam, lies unconformably upon the Gault. It is succeeded by various divisions of the Chalk up to the zone of *Micraster*.

The glacial deposits consist chiefly of the Chalky Boulder-clay; the great boulder at Ely is also of interest.

The Pleistocene gravels include the plateau gravels on the Chalk hills and the well-known mammaliferous gravels forming terraces on the valley-sides. The March marine gravels are usually correlated with the gravels of one of these terraces.

Alluvium is found on the valley-bottoms, and in the fenland peat occurs with intercalated patches of *Scrobicularia* clay. The peat contains the fauna of Neolithic and later times.

III.—The Great Eastern Glacier. By F. W. Harmer, F.G.S.[1]

THIS name is proposed for the great ice-stream the moraine of which, the Chalky Boulder-clay, covers an area of more than 5,000 square miles in the east of England, frequently attaining a thickness of more than 100 feet.

As far back as 1858, Trimmer, a pioneer in glacial investigation, pointed out that the county of Norfolk had been twice invaded by ice, first from the North Sea and then from the west, the resulting detritus in the one case being characterised by igneous blocks, some of them of Scandinavian origin; and in the other by a predominance of Jurassic material. The first invasion is represented by the Cromer Till and the Contorted Drift of the Norfolk coast; the second, by the Chalky Boulder-clay, the subject of the present paper, which does not occur in north-east Norfolk.

The region covered by the latter deposit, which extends over a great part of the eastern counties of England, has a palmate outline, its lobes, which radiate from the great depression of the Lincolnshire and Cambridgeshire Fens, being of unequal length. The latter region was not only the centre whence the Chalky Boulder-clay of the southern part of the area was distributed, but also the quarry out of which was excavated most of the enormous mass of Jurassic material of which the matrix of this deposit is so largely composed.

The present physiographical features of the east of England resemble, more or less, those which obtained in Glacial times, the Drift deposits not only covering the plateaux between the valleys in which the rivers of the district now run, but descending into them, sometimes to below sea-level. Hence by the study of the existing contours, aided by that of well-borings, it is possible to obtain a general idea of the pre-Glacial topography by which the movements of the ice must have been determined or influenced.

Although the erratics of the Chalky Boulder-clay are more or less of a similar character over a wide area, indicating that it was distributed from a common centre, the predominant character of its

[1] Abstract of paper read before the British Association, Cambridge, Section C (Geology), August, 1904.

detritus varies in different districts, in accordance with that of the strata over which the ice had moved. The matrix of the Boulder-clay of South Norfolk and North Suffolk, for example, has been largely derived from the Kimmeridge Clay. Over this region, which formed in Glacial times a shallow trough running east and west, corresponding with the present depression of the basins of the Little Ouse and the Waveney, as well as with the gap in the Chalk escarpment between Swaffham and Newmarket, the ice evidently poured in great volume, planing down the surface of the Chalk and carrying its Kimmeridgian material fifty miles to the east from its original source in the Fen basin. On the other hand, although the Fen ice was sufficiently thick to enable it to overflow the Chalk hills between Newmarket and Royston, it only travelled thence to the south-east for about half that distance. In this region the Boulder-clay is chalky near the escarpment, while beyond the outcrop of the London Clay it is mainly composed of detritus from that formation.

Along the basin of the Ouse, where its matrix is largely Oxfordian, the ice to which it was due advanced much further, to Buckingham and beyond, as it also did along that of the Nene, in the direction of Northampton, where Liassic débris is common. On the contrary, the high land near the head waters of the Welland obstructed the ice-flow, so that but little Boulder-clay seems to have found its way into the area comprised in Sheet 53 of the Ordnance map. The greater part of Sheet 63, however, is covered by it, and it there reaches an elevation of 730 feet above the sea-level. Much of the Boulder-clay of this region, in the author's opinion, was due to the ice-stream of the Trent Valley, having been piled up upon the high land to the east of Leicester by the pressure of ice descending from the Pennines.

It seems probable that the whole of the low-lying region between the Lincolnshire Wolds and the Pennines was filled with ice during the period of maximum glaciation. It is not physically possible that any considerable thickness of ice could have existed on one side only of the Lincolnshire ridge, which does not often exceed an elevation of about 200 feet above the lower ground adjoining it.

The author hopes to make the ultimate source of the Chalky Boulder-clay ice the subject of a future paper. The prevalence of Carboniferous débris in the East Anglian region seems to indicate, however, that a part of it at least was of Pennine origin; another part may have been due to an overflow from the North Sea across the lower part of the Chalk Wolds, and the ice may also have been reinforced by the abundant precipitation to which this district was subject during the Glacial period; the moisture-bearing cyclonic disturbances from the Atlantic, to which the enormous accumulation of ice in the Baltic region was due, must have passed near the eastern counties of England. There is no evidence to show that any considerable amount of ice entered East Anglia through the Wash gap during the Chalky Boulder-clay period, all the facts known to the author appearing to point in an opposite direction.

IV.—On a Great Depth of Drift in the Valley of the Stour. By W. Whitaker, F.R.S.[1]

SEVERAL cases of great irregularities in the thickness of the Drift have been shown by borings in Suffolk, and the existence of deep channels filled with Drift has been practically proved, as also in the neighbouring counties of Essex and Norfolk. In some cases these channels cannot be shown on the map, the Glacial Drift being hidden by deposits of later age, and this is markedly the case in the upper part of the valley of the Cam, where at one place (Newport) the Drift has been pierced to the depth of 340 feet without reaching the bottom.

In Suffolk the greatest amount of Drift recorded is at Brettenham Park, where apparently a thickness of 312 feet has been found. But this and all other records in East Anglia are now put into the shade by the result of a boring near Glemsford railway station. This is at a low level in the valley of the Stour, in the tract formed by the sand and gravel that crop out from beneath the Boulder-clay of the higher ground. Here one would have expected, perhaps, some 50 feet of Drift, but certainly not more than 100. No less than 477 feet have been passed through before reaching the Chalk.

The gravel and sand that form the surface reached to a depth of 51 feet, as might have been expected; but then the unexpected occurred, no less than 228 feet of Boulder-clay (partly sandy) having been found, with a mass of sand and clayey sand beneath.

We seem here, then, again to have evidence of a very deep Drift-filled channel. A well in the village, at a higher level, has reached Chalk after passing through 120 feet of Drift; so the channel does not reach far northward, nor does it reach to Foxearth, in Essex, about a mile to the south, where there is a still less thickness of Drift. As to its direction or extent, however, we can say little as yet.

One may add that a boring (? unfinished) in Euston Park has proved over 150 feet of Drift, at a spot where no Drift is shown on the map. This may be simply a huge pipe.

V.—Some Cambridgeshire Wells. By W. Whitaker, F.R.S.[1]

SINCE the publication of the latest Geological Survey memoir dealing with the county further records of nineteen additional well-sections at sixteen places have been obtained.

These vary in depth from 40 to 284 feet, and pass through various formations from Drift to Lower Greensand. None have any special interest; but the whole forms a useful addition to our knowledge of the geology and water-supply of the county.

[1] Abstract of paper read before the British Association, Cambridge, Section C (Geology), August, 1904.

VI.—Report of the Committee to investigate the Fossiliferous Deposits at Kirmington, Lincolnshire, and at various localities in the East Riding of Yorkshire. Chairman, Mr. G. W. Lamplugh; Secretary, Mr. J. W. Stather.[1]

IT has only been found possible during the present year to complete the investigation of the deposits at Kirmington and Great Limber, but it is hoped in the future to extend operations to Bielbecks and several other sections that require further elucidation.

Kirmington Section.

The work on this important section, which was begun last year, has now been carried to a successful conclusion; and the results show that in some respects this section has no known parallel in English drift sections. It will be remembered that, as described in last year's report, a brickyard is worked at this place in a mass of warp or clay containing estuarine shells, with a fresh-water bed at its base, and that this deposit is overlain by a bed of coarse flinty shingle, above which in one part of the pit there is found a few feet of red stony clay believed to be a boulder-clay. The boring last year proved the presence of a glacial clay at some depth beneath the warp. The chief object of our investigation has been to discover the relationship of the fossiliferous warp to the Glacial Series, and to carry the boring through the superficial deposits to the chalk, which was not reached last year.

During June of the present year a new boring was carried out under the personal supervision of the Chairman and Secretary, with the assistance of Mr. G. W. B. Macturk. Mr. Villiers, well engineer, of Beverley, undertook to put down the boring, and the Committee desire to express their indebtedness to him for the ready manner in which, at considerable personal inconvenience, he met their wishes as to the time and conditions of the work.

In order to secure a section in another part of the pit, the site of the new boring was fixed at a point 80 yards north-east of last year's boring. Although at the spot chosen the warp used for brickmaking had been excavated to a depth of 5 feet below the level of its base at the former site, this material was passed through in the new boring to a further depth of 3 feet, so that its base is here 8 feet below its position in the former boring. The total depth attained by the new boring, combined with the height of the open section, was 96 feet, or 41 feet lower than was reached last year. The surface of the chalk lay much deeper than was anticipated, and the borings seem to prove that the surface features of the locality are not due to the presence of chalk, as hitherto supposed, but that the rising ground has been formed by the erosion of a thick and complex mass of drift.

[1] Abstract of paper read before the British Association, Cambridge, Section C (Geology), August, 1904.

The diameter of the second boring was at first 4 inches, narrowing to 3 inches at a depth of 15 feet. It was found necessary to line the boring with the tubes throughout.

The section seen in the brickyard and proved in the borehole was as follows :—

	ft.	in.
Surface soil (at 95 feet above O.D.)	1	0
Clay with foreign stones (see NOTE A)	4	0
Well-worn shingle, principally of battered flints	8	0
Laminated warp with estuarine shells, and at its base a thin seam of peat associated with a sandy warp containing fresh-water shells in one part of the pit (see NOTE B)	18	6
Clean yellow sand, with pebbles of chalk and flint	4	9
Red clay passing downwards into tough reddish-brown clay ...	7	6
Purple clay, streaked with silt and loam, passing downwards into tough purple clay with small stones, including some erratics (see NOTE C)	10	6
Stoneless purple clay	5	0
Stoneless yellow clay	6	0
Flinty gravel	4	6
Yellow clay and loam with small dritt pebbles	5	0
Yellow sand, full of well-rounded quartz grains and specks of chalk	8	0
Yellow sand and laminated clay	4	0
Tough compact bluish-grey or lead-coloured clay, with a few small foreign pebbles (see NOTE D)	5	3
Tough yellow clay streaked with chalk	1	0
Solid chalk and flint	3	0
Total	96	0

NOTE A.—Among the erratic stones which this clay contains the following were identified: basalt, porphyrites, rhomb-porphyry, grits, etc.

NOTE B.—Mr. Clement Reid records from this bed *Scrobicularia piperata*, *Rissoa ulvæ*, *Tellina balthica*, *Cardium edule*, *Mactra subtruncata*, *Mytilus edulis*, and abundant Foraminifera (see Mem. Geol. Survey, Holderness, p. 58).

NOTE C.—In general appearance this clay resembles the Purple Clay of Holderness. Among the pebbles washed out of 30 lb. of the clay brought up by the augre, chalk and flint greatly predominate, but the following rocks were also represented: red chalk, black flint, Spilsby sandstone, ferruginous pebbles, quartz, basalt, and porphyrites, besides many undeterminable small pebbles.

NOTE D.—This clay is hard and tough, and very different from A and C both in texture and colour. It resembles in colour the Basement Clay of Holderness. The pebbles are smaller in size than in C, and there is a still higher proportion of chalk and flint. Among the erratic pebbles the following are recognizable: basalt, porphyrite, sandstone, black flint, grit, quartz, etc.

Mr. Reid has examined the plant remains obtained by the Committee from the band at the base of the warp, and reports as follows :—"The plant remains obtained by Mr. Stather from the peaty warp belong to the following species :—

Ranunculus sceleratus, Linn.
Eupatorium cannabinum, Linn.
Aster Tripolium, Linn.
Lapsana communis, Linn.
Mentha aquatica, Linn.
Labiate (much crushed)
Atriplex?
Zannichellia pedunculata, Reichb.
Scirpus setaceus, Linn.
,, *maritimus*, Linn.
,, sp.
Carex incurva, Lightf.

"The list is a small one, but it indicates estuarine conditions, and suggests a sub-arctic climate. With one exception the plants are still to be found in the neighbourhood of the Humber; but one of

them, *Carex incurva*, is a sea-coast sedge not now ranging south of Holy Isle.

"A striking peculiarity of the deposit is the abundant remains of the estuarine sedge, *Scirpus maritimus*, a plant which, growing out of a few inches of water, tends to form a thick belt through which few drifted seeds would find their way. In view of the abundance of this sedge in the bed now examined and of the like-growing reed, *Phragmites communis*, in the deposit which I searched some years ago, the small number of other plants yet detected is not surprising. Land plants are only represented by two fruits of *Lapsana*, perhaps brought by birds. These fruits of *Lapsana*, as well as those of the sea-aster, are considerably smaller than my recent specimens, but I have not yet had an opportunity of comparing them with fruits of the same species near their northern limit."

From the fresh-water shell-bed associated with the peat, Mr. E. T. Newton has determined *Planorbis spirorbis*, *Bithynia tentaculata*, with probably *Candona* (an Entomostracan).

Great Limber Section.

A boring was also put down under the supervision of Mr. G. W. B. Macturk, who kindly undertook to aid the Committee in this manner, at the Great Limber brickyard, three miles south-east of Kirmington, where there is a further development of warp and sand, believed by Mr. C. Reid to be of the same age as the Kirmington deposit, though no fossils have been found in it. The section seen in the brickyard and proved in the boring was as follows :—

	ft.	in.
Surface soil and clay with stones (at 110 feet above O.D.)	4	0
Loamy sand contorted and mixed with warp	4	0
Laminated blue warp with sandy streaks	10	0
Pan	1	3
Current-bedded sand	4	9
Sharp sand	8	0
Flint, sand, and rounded chalk pebbles	5	0
Solid chalk with flints	1	0
Total	38	0

In comparing this section with the one at Kirmington it should be noted, (1) that no shells have been found in the laminated warp at Limber; (2) that the warp does not rest on glacial clays; and (3) that the base of the Limber warp is 92 feet above O.D., or 28 feet higher than that of Kirmington.

It would be premature to discuss the problems raised by these interesting sections until the work of the Committee has been carried further. For the present, therefore, we desire only to record the data thus far obtained.

The thanks of the Committee are due to Mr. W. H. Crofts and Mr. G. W. B. Macturk for practical help in many ways; also to the Earl of Yarborough (landlord), E. P. Hankey, Esq. (agent), and the occupiers of the brickyards—Mr. Hervey and Mr. John Housan—for permission to put down the borings.

VII.—Geology and Agriculture. By F. J. Bennett, F.G.S.

[Abridged from article contributed to the *Land Agents' Record* (August 20th, 1904) on the uses to which Ordnance Maps might be put for Estate Records.]

MUCH valuable information is lost, both to the landowner and farmer, to say nothing of the geologist, for want of recording it at the time. How often is land drained and no record made of the soil turned out, and the courses of the drains not laid down on the estate maps? Post-holes and excavations of all kinds are made and no record kept at the time. And yet how easy to put all these down on the map itself, a record for all future time, and constantly under the eye of the owner and occupier. The map itself, the back as well as the front, is most obviously the proper place for these notes. Yet how very few persons use these maps in this way.

Scotch farmers seem to succeed in England where our farmers cannot, and why is this? One great reason is that they are far more systematic than ours are, and they record the results of each field year by year.

Let us take the case of a person purchasing an estate. To a large extent he would, in a usual way, be very much in the dark as to the real nature of the property he had purchased. He would, of course, have all the information the seller could afford him, and that would vary very much according to the way in which the estate had been managed. He might be able to obtain 1 in. or even 6 in. maps of the Geological Survey, both Solid and Drift, with, in many cases, the accompanying memoirs; and, according as he was able to understand them, they would give him much or little information. Yet to most this would be of a superficial or vague nature on many points, and perhaps could not give the details most useful to him. But if he had followed the plan adopted, I believe, in the best estate offices, the 25 in. Ordnance maps would have been used, and on these maps all the divisions of the fields would have been marked at the time the survey was made, and the estate maps would, no doubt, have been brought up to date by marking on them any alteration subsequently made. There would, no doubt, be a schedule of the amount of arable and pasture and woodland, with the kind of trees, water, and roads, and there might be a rough division of the soil into heavy and light.

Soil.—Now, let us suppose that the late owner had made these maps in the way this paper suggests. Say, that on each field division be noted the nature of the soil and subsoil, whether clay, sand, loam, gravel, chalk, etc., and the qualifying character of these. Of course difficulties would arise as to how this information could be obtained. Here, then, I would suggest that a visit should be paid to the Geological Survey Office to ascertain what information was available. As a very useful preliminary to this visit, trial holes, or trenches preferably, could be dug, especially in the pasture lands, so that the subsoil could be exposed. In this way a kind of soil map could be made and recorded on the map or schedule accompanying

it. Field names should also be noted, with their oldest and latest ways of spelling these, with the dates.

Wells.—These should be all marked on the map, whether in use or not, and all measured, and their total depth given, and that of the water and the variation of this, and, where possible, a record of the soils and subsoils met with when this well was sunk and the name of the sinker.

Springs.—All these should be marked, and their variations and highest point in any special year, going as far back as possible.

Quarries.—All these should be noted, and characters recorded on the map.

Pits.—Where old pits exist, often, of course, grown over, it will be found of the utmost importance, where all record has been lost, that they should be cleared and their true character ascertained.

Drains.—Now, perhaps, the most important detail has been left to the last. I am informed that, in most cases, where land has been drained the courses of the drains have not been laid down on the estate maps, so that very often much of the money thus expended has, for practical purposes in after years, been lost, and where the drains have ceased to work much time and expense have been incurred, sometimes to no purpose, in seeking the outlets, etc. All this would have been avoided had their courses been laid down on the maps. To record the nature of the soil dug out, when drains are being made, is of the utmost importance to the agriculturist and geologist, and this should be especially noted on the map. As the Government indirectly lends large sums of money for land drainage I would suggest that the Government stipulate in the future that the courses of all land drains should be laid down on the estate maps, and the nature of the soil recorded, and that a copy and tracing of the drains be deposited with the Government Department.

I would here suggest a further use of these 25 in. maps for the recording on them by farmers of certain agricultural notes relating to crops, etc.

On each of the field divisions year by year, and in one line if possible (so that the records of several successive years might be placed on the same division for reference, especially if contractions were used), should be noted the amount of seed sown, the kind and quantity of manure used, and the weather at the time; also the result of the crop, such as weight of grain, length of straw, etc., and the same with other crops. If the results of seven years were thus recorded they could be taken in at a glance and the reason often seen for success in one year and failure in another, and the varying results where different manures had been used could also be noted in a field-book. The different kinds of trees and their growth in relation to the soil should be noted both by farmers and landowners. Many farmers, no doubt, would object to all this as an additional and useless labour on their part; but I would suggest that such information would be of the utmost value to the incoming farmer, and would, of course, be the private property of the late occupier. The incoming tenant should be very glad to

pay a very substantial sum for this accumulated information, as, without this, he might have to spend years and lose much valuable time and money in finding it out. Thus the late occupier would find that he had not only been getting together much valuable information for himself, but information of such a nature that the incoming tenant would be glad to buy it.

VIII.—Brief Notices.

1. The Yorkshire Philosophical Society.—The Annual Report of this Society for 1903 is a trifle more bulky than usual, separate copies of Dr. Anderson's paper on the West Indian Eruption, which was published by the Royal Geographical Society, together with the 12 plates and map which accompanied the original paper, being inserted.

2. Cambrian of Portugal. — A fine series of fossils from the calcareous schists of Alemtejo is described by J. F. Nery Delgado (see Comm. Serv. Geol. Portugal, 1904, 6 pls.). Delgado considers the fauna nearly allied to that of *Olenellus*, and that it is more ancient than the Cambrian fauna of Spain, which certainly belongs to the zone of *Paradoxides*. The fauna contains *Paradoxides*, *Olenopsis*, *Ilicksia*, *Microdiscus*, *Metadoxides*, and *Olenellus* among the Trilobites, *Lingulella*, *Obolella*, *Acrothele*, *Hyolithes*, and many Lamellibranchs. The plates contain photographic figures and are excellently produced.

3. Reclassification of the Reptilia. — Professor Osborn has printed in the *American Naturalist* for February, 1904, his paper on the reclassification of the Reptilia, read before the Society of Vertebrate Palæontologists at Philadelphia in December, 1903. He arrives at the following conclusions :—

The birds probably originated from a group of Diaptosauria identical with or closely related to that which gave rise to the Dinosauria. It is not true that birds have descended from Dinosaurs, but there is very strong evidence that birds and Dinosaurs are descended from a common stock.

There is no question that the mammals are affiliated with the subclass Synapsida rather than with the Diapsida; both in skull and shoulder-girdle structure and in the phalangeal formula they are Synapsidan. As to their nearer relationships they appear to be rather with the superorder Anomodontia and with the order Cynodontia or Theriodontia. The divergence of the mammal stem from these typical reptiles will probably be found to have occurred in the Permian or Trias of South Africa.

4. Geology of Tunis.—Under the title "Etude géologique de la Tunisie centrale," Dr. L. Pervinquière has written a detailed monograph around a really magnificent map of the country, geologically coloured. The formations dealt with range from the Pleistocene to the Trias, the fossils themselves being referable to the Lias, Oxfordian, Portlandian, Neocomian, Aptian, Arbian, Cenomanian,

Turonian, Senonian, Eocene, Oligocene, Miocene, and Pliocene. The country seems remarkable for the isolated Triassic hills which stand up boldly from the surrounding country. A list of previous works on Tunis is given, and M. Pervinquière deserves our thanks for a valuable addition to African geology. The book is issued from Paris (Direction Générale des Travaux Publics), 1903. Price 15 frs.

5. *Merycodus.*—A fine and perfect skeleton of the hypsodont group of ruminants has been described and figured by W. D. Matthew (in the Bull. Amer. Mus. N.H., xx, 1904). This is *Merycodus osborni*, a form related to the antelopes, but with branching, deciduous antlers like those of the deer. The specimen came from the Middle Miocene (Pawnee Creek Beds) of north-eastern Colorado, and was found by Mr. Barnum Brown, of the American Museum Expedition of 1901. The paper sketches the other known species of the genus as well as species of the genera *Blastomeryx*, *Lapromeryx*, and *Palæomeryx*.

6. The Mines of Hualgayoc, Peru.—Situated in a volcanic region, in which the sedimentary rocks seem to be of Cretaceous age from their fossil contents, the mines of Hualgayoc yield an abundance of minerals. Those chiefly worked are lead and copper, and this paper (published in the Bol. Cuerpo Ingen. Minas Peru, No. 6, 1904), by F. Malaga Santolalla, is mainly devoted to them. Hualgayoc is a province of Peru, and the author prefaces his description of the mines with a sketch of the geography, history, and geology of the area. The paper is well illustrated and has a topographical map.

7. Tertiary Fauna of Florida.—Dr. W. H. Dall has recently published in the Transactions of the Wagner Free Institute of Science the concluding part of his "Contributions to the Tertiary Fauna of Florida." This consists of the molluscan fauna of the Silex beds of Tampa and the Pliocene beds of the Caloosahatchie river, and includes in many cases a complete revision of the generic groups treated of and their American Tertiary species. This part vi runs from p. 1219 to p. 1654, pls. xlviii–lx, and with an index brings a laborious and valuable work to a successful conclusion.

8. North Polar Expedition, 1893–96.—Messrs. Longmans & Co. have published vol. iv of the scientific results of this expedition, edited by Dr. Fridtjof Nansen. The volume before us contains Dr. Johan Kieer's paper in the Lower Silurian at Khabarora. The age of the beds appears to be of the Scandinavian Esthonian type, and praise is due to Dr. Kieer and Dr. Brögger for successfully dealing with such unpromising material. Dr. Nansen contributes to this volume his "Bathymetrical features of the North Polar seas, with a discussion of the continental shelves and previous oscillations of the shore-line," illustrated by maps and plates.[1]

9. Relief Map of North America.—Although dated as long ago as 1901, it may be worth while to call attention to a publication of the Geological Survey of Canada entitled "Altitudes in the Dominion

[1] See Professor Hall's Review in our August Number, p. 422.—Ed. Geol. Mag.

of Canada, with a Relief Map of North America." This is on a scale of 200 miles to an inch, and shows elevations at 100, 1000, 5000, 10,000, and above 10,000 feet, and does not seem to be generally known.

10. Primitive Fossil Fishes.—M. Ad. Kemna contributes to the Bull. Soc. Belge Géol., xvii, 1903 (1904), a general review of recent discoveries in fossil fishes of the earliest period. The writer bases his review on the papers of Dr. Traquair and Dr. Smith Woodward, and after pointing out the importance of the more ancient fishes, refers to their zoological position, and sketches in some detail the families Heterostracidæ, Osteostracidæ, and Anaspidæ.

11. Excursions in Belgium.—M. Rutot has provided a full report of the excursion of the Belgian Society of Geology, Palæontology, and Hydrology to Hainaut and the environs of Brussels in 1902. It is published in the Bulletin, xvii (5), 1904. The district traversed was from Erguelinnes to Leval-Trahegnies, Mons, Vaulx lez-Tournai, Blaton and Hautrage, Brussels and environs; and the jaded British geologist might do worse than spend his four days over this ground. The geology covers the Landenian, Bruxellian, Ypresian, and Montian, and fossils are abundant.

12. Oligocene of Poland.—M. K. Wójcik has found in a small valley in Kruhel Maly, near Przemysl, on the northern border of the Middle Carpathians, a dark clay or sandy clay-bed with Mollusca and Foraminifera. Of the forms found 46 out of 60 belong to the Lower Oligocene of North Germany, as described by Von Koenen, and 8 of the 14 remaining species are found in the Vicentinian beds described by Fuchs and Oppenheim. The whole fauna is comparable to that of the *Clavulina szaboi* beds of Von Hantken. Accompanying the paper, which appears in the Bull. intern. Ac. Sci. Cracovie, 1893, No. 10, are two plates of shells and Foraminifera.

13. Minerals of Colombia. — A new journal has reached us from the Republic of Colombia, "Trabajos de la Oficina de Historia Natural," Bogata, 1904. This tract of 27 pages contains an account of the alkaline and earthy minerals of Colombia, by Ricardo Lleras Codazzi, chief of the section of Mineralogy and Geology.

14. Cinnabar from Peru.—Augusto F. Umlauff publishes in the seventh "Boletin del Cuerpo Ingenieros de Minas del Peru" a long account of the Huan Cavelica mercury deposits, with map and sections. The ore seems to occur indiscriminately throughout the mass, as at Santa Barbara it is described and figured as occurring in Andesites, Amphibolites, Basalts, Sandstones, Limestones with Cretaceous mollusca, and Conglomerates. No description of the fossils is given; it being merely stated "molluscs and others very abundant."

15. 'Exotic Blocks' of the Himalayas.—In the Comptes Rendus of the Ninth Congress of Geologists held at Vienna in 1903, just published, we find Dr. C. L. Griesbach's note on the 'exotic blocks' of the Himalayas. These are masses of limestones of Nummulitic

age, often converted into marble, which rest, and in some cases are enclosed in, igneous rocks. They occur in the Tibetan area. These blocks would appear to be the result of the action of huge igneous flows, which, passing through the dislocated rocks, tore off and bore to the surface masses of rudimentary rock, together with other loose masses, the result of the dislocating and faulting itself. Dr. Griesbach thinks that all this was part of the general Himalayan upheaval, which falls into the period after the deposition of the Upper Cretaceous system and prior to the deposition of the younger Tertiaries, and fits into the period during which the great flows of Dekkan Trap took place in India.

16. Bradford Glacial Lakes.—The Bradford Scientific Association have started a new quarterly called the *Bradford Scientific Journal* (No. 1, July 1904), and the opening paper deals with "The Glacial Lakes of the Bradford District," by J. E. Wilson. The author gives a map, and states that a note of his conclusions appeared in the Report of the British Association for 1900.

17. Persimmon Creek Meteorite.—This iron came from North Carolina in 1893, and is now in the U.S. National Museum. It is described in the Proc. U.S. Nat. Mus., xxvii (1904), by Wirt Tassin, as "a more or less continuous matrix of iron containing troilite, schreibersite, and carbon." Its present weight is 9 lb. 6 oz., but a fragment weighing about 1 lb. 13 oz. has been broken off.

18. Museums.—It may be well to call attention to the Vorberichte für die xii Konferenz (Centralstelle für Arbeiter-Wohlfahrtseinrichtungen), 1903, in Mannheim, which contains Gill Parker's account of the Ruskin Museum and Lehmann's account of the Altona Museum, among other papers.

19. Fresh Fossil Egg.—Messrs. W. C. Morgan and M. C. Tallman described in Bull. Geol. Univ. Calif. Publications (iii, 1904) an egg from a pebble in a placer deposit on the Gila river in Arizona. The egg formed the centre of a rounded mass of hard calcareous rock, which was removed so as to allow of an examination of a fresh surface of the shell. The authors say that the egg corresponds fairly well to the type of egg laid by a cormorant, and with that and some photographic illustrations we must content ourselves.

20. Erratic Blocks.—Special attention should be called to the Eighth Report of the Committee on the Erratic Blocks of the British Isles (Rep. Brit. Assoc. for 1903, 1904), as in it the Secretary, Professor Percy F. Kendall, has drawn up a summary of the records accumulated during the past thirty-two years from England, Wales, the Isle of Man, and Scotland.

21. The "Records of the Geological Survey of India," established in 1868, published hitherto in yearly volumes until 1897, when it was amalgamated with the "Memoirs." With a view to the rapid publication of short papers and notes on Indian geology, it is now being continued again as before. Private workers are invited to contribute. The current number (vol. xxxi, pt. 1, 1904) contains

papers of economic importance; on an occurrence of copper ore in the Darjiling district, and on coal deposits in Punjab and Assam. Various mineralogical notes and technical assays are appended.

22. *Stylonurus* in the Baltic Silurian.—The genus *Stylonurus* has not hitherto been recorded from the Baltic region, but Dr. F. Schmidt, in examining a specimen collected from the uppermost Silurian of Rotziküll on the Island of Oesel, has come to the conclusion that it represents a fragment of this Merostomatous Arthropod. He bases this conclusion on the general form of the body, which tapers somewhat rapidly backwards, the shape of the four-jointed limb fragment with terminal spines, and the ornament of the body-segments. At the same time the species, which he names *Stylonurus* (?) *Simonsoni*, after the collector, may belong to some hitherto undescribed genus. The specimen presents some interesting features, especially two grooves on the dorsal side of the carapace, giving it a somewhat trilobed appearance. Portions of the underside of the head-shield are preserved, including a complete metastoma, a structure hitherto unknown in *Stylonurus*; it is distinguished by its pyriform outline. Dr. Schmidt's paper, which appeared in the *Bulletin* of the Imperial Academy of Sciences of St. Petersburg for March, 1904, is illustrated by a plate.

23. A large *Prestwichia*.—Among the papers of the late Professor C. E. Beecher was found a manuscript which has been printed in the Amer. Journ. Sci., July, 1904. This manuscript describes (and figures) a cephalothorax of *Prestwichia signata*, sp.n., from the Fort Riley Limestone of the Lower Permian, three miles west of Stockdale, Kansas. The specimen has a length of 45 mm., and is of especial interest as coming from a higher horizon than any other American species yet known.

REVIEWS.

The History of the Collections contained in the Natural History Departments of the British Museum. Vol. I: The Libraries—The Department of Botany—The Department of Geology—The Department of Minerals. 8vo; pp. xviii and 442. (London: printed by order of the Trustees of the British Museum. Sold by Dulau & Co., 37, Soho Square, W., and others. 1904. Price 15*s*.)

THIS volume contains the history of the libraries and of the collections in the Departments of Botany, Geology, and Minerals. A second volume (not yet issued) will contain the history of the collections in the Department of Zoology.

"The possibility of producing such a history as the present is," says the Director in his Preface, "a remarkable evidence of the care and efficiency with which the records of the Museum have been kept during the past century. The value of the book to workers in the various branches of Natural History will be very

great. It not only furnishes an interesting record of the names of hundreds who have contributed to build up our science during the nineteenth century, but it will prove to be of assistance to investigators who are anxious to discover the present depository of specimens or collections referred to in old publications and to compare them with later examples. It will also furnish to a very large number of persons, who at present are not informed on the subject, a correct idea of the variety, extent, and importance of the immense series of collected specimens which are here carefully guarded and kept in orderly arrangement, 'not only' (according to the terms of Sir Hans Sloane's will) 'for the inspection and entertainment of the learned and curious, but for the general use and benefit of the public to all posterity.'

"Mr. B. B. Woodward has written the history of the libraries; Mr. George Murray, assisted by Mr. Britten, that of the Department of Botany; Dr. Arthur Smith Woodward, with valuable help from the late Keeper, Dr. Henry Woodward, and from the present Assistant Keeper, Dr. Bather, that of the Department of Geology; and Mr. Fletcher, that of the Department of Minerals."

The actual foundation of the British Museum dates from the year 1753, when an Act of Parliament was passed "for the purchase of the Museum or Collection of Sir Hans Sloane, and of the Harleian Collection of Manuscripts, and for providing one general repository for the better reception and more convenient use of the said Collections and of the Cottonian Library and the additions thereto."

The collection of Sir Hans Sloane contained in his residence, The Manor House, Chelsea, consisted of "books, drawings, manuscripts, prints, medals and coins, ancient and modern antiquities, seals, cameos and intaglios, precious stones, agates, jaspers, vessels of agate and jasper, crystals, mathematical instruments, pictures, and other things," which last included numerous zoological and geological specimens and an extensive herbarium of dried plants preserved in 310 large folio volumes.

The Cotton Manuscripts were already the property of the nation, having been acquired by gift in 1700. The Harleian Collection was obtained by purchase at the same time as the Sloane Collection, and the three were brought together under the designation of "the British Museum," placed under the care of a body of Trustees, and lodged in Montagu House, Bloomsbury, purchased for their reception in 1754.

Admission to visit the Museum was limited by ticket, issued only on application in writing, and to not more than ten persons for each of three hours in the day; the hours were subsequently extended, but it was not until the year 1810 that the Museum was accessible to the general public for three days in the week from 10 o'clock to 4. The present daily opening, with longer hours in Summer, dates only from 1879. The collections soon outgrew the limits of the original Montagu House and also its successor, the present classical building, completed in 1845. The erection of the magnificent reading-room in 1857 disposed for a time of the difficulty

of finding accommodation for the ever-growing library, but the keepers of the other departments continued urgent in their demands for more space; and after much discussion of rival plans for keeping the collections together and obtaining the needful extension of room by acquiring the property immediately around the old Museum, or for severing the collections and removing a portion to another building on a fresh site, the latter course was finally decided upon. In 1863 the House of Commons sanctioned the purchase of part of the site of the International Exhibition of 1862, in Cromwell Road, South Kensington, with a view to appropriating it to the purpose of a Museum of Natural History.

The considerations of the various plans for the new buildings occupied a long period of time, Mr. Alfred Waterhouse, the architect, finally obtaining for his design the approval of the Trustees in 1871. The present building was commenced in 1873, and was handed over to the Trustees completed, but without internal fittings, in June, 1880. The great labour of removing the collections to the new building was commenced, and a part of the Departments of Geology and Mineralogy were opened to the public on April 18th, 1881.

The history of the growth of the great collections in the British Museum runs parallel to the growth of natural knowledge, as exemplified by the establishment of the various learned Societies which have been founded for its promotion. Thus, in 1756 the National Museum consisted of three departments only, (1) Printed Books, (2) Manuscripts, (3) Natural History; strange to say, this last department included antiquities, coins, and medals! In 1807 the last-named department was divided into the Department of Natural History and Modern Curiosities and of the Department of Antiquities and Coins.

In 1827 Robert Brown was appointed Keeper of Sir Joseph Banks' Botanical Collection, and by adding to this the Sloane herbarium and other dried plants a separate Department of Botany was formed. In 1837 the Mineralogical and Geological branch, under Mr. C. König, Keeper, and the Zoological branch, under Mr. J. G. Children, were created. The last subdivision occurred in 1857, when Mineralogy and Geology were split up into two departments, and the four departments so formed have remained intact to the present time.

Originally, the Royal Society, which was founded in 1660,[1] *represented all the Natural Sciences* till 1788, when the Botanists seceded, with others, and formed the Linnean Society. The Geologists made another separate Society in 1807, and the Astronomers in 1821. The Zoological Society commenced its existence in 1826. The Chemists founded a separate Society in 1841. Many others might be named, as the Entomological Society founded in 1833, while the Mineralogical and Malacological Societies have a still more recent origin. But the swing of the pendulum of time seems now changing in favour of reunion, or perhaps of reorganisation; and

[1] The Antiquaries formed a Society in 1572, were dissolved in 1604, reconstituted in 1717, and obtained their charter in 1751.

one would not be surprised to learn that Zoology and Palæontology in the Natural History Museum had been recombined together as representing Animal Biology; in fact, the late Director, Sir William Flower, and the present Director, Professor Ray Lankester, have both strenuously aimed at bringing the recent and extinct forms of animal life together into one series. It is remarkable that notwithstanding the various attempts to change the existing order of things (as e.g. that of the Kew authorities to absorb the Botanical Department into the Kew Herbarium, and the plan suggested by Professor Maskelyne, many years ago, to transfer the Mineral Collections to the Royal College of Chemistry, or to the Royal School of Mines), they all failed, and these departments still remain firmly united to the Natural History Museum, and the Geological Department still enjoys a separate and distinct existence.

It would be impossible in a brief notice like the present to give an adequate notion of the amount of labour bestowed in working up the historical records of the Museum in the past 150 years, presented to us in this interesting volume, bringing out as it does, in an orderly and succinct form, the story of the three great Departments and of the Libraries attached to them; but to any person interested in the progress of Natural History in this country this book will afford the greatest pleasure, not only to read, but to possess, as a most valuable work of reference for all time.

CORRESPONDENCE.

ICE-ACTION ON WINDERMERE.

Sir,—As one of the party that visited the cliffs in the neighbourhood of Cromer in connection with the recent meeting of the British Association, I was greatly interested, as we all were, with what we saw and with the able exposition given by Mr. Clement Reid; and it occurred to me that what I have observed of ice-action on a small scale when Windermere, in 1895, was completely frozen over might be of some interest to students of ice-action on a far grander scale in past ages, of which we see traces in the present day. I was encouraged in this view by some of the members of Section C to whom I mentioned what I had seen. I will simply state the facts without attempting to found any theory upon them.

During the Winter in question Windermere was frozen throughout its entire extent, the ice attaining a thickness in many places of seven to eight inches or more. Wherever there was a considerable expanse of water, as for instance between Thompson Holme and the northern shore of Miller Ground Bay, a distance of about two miles, the expansion which takes place in freezing forced the ice up on the shore wherever the slope was sufficiently gentle to permit of this. The striation produced by this glaciation was clearly to be seen below the ice where the bottom was chiefly composed of clay. Where the shore was composed of loose shingle the ice in its progress ploughed its way through it, raising a bank of from one

to two feet in height. Where the shore presented miniature cliffs of clay capped by turf, the soil was turned over by the ice as by a ploughshare. Along the greater part of the shore-line, but especially where the shore was steep or rocky, the pressure forced the ice up into hummocky fragments. Great cracks, the edges of which were similarly thrown into hummocks, extended right across the lake at two points between Bowness and Ambleside. When the thaw set in and the ice contracted, the position of these two loci of compression was marked by wide lanes of open water, while the ice on either side was still strong enough to bear the weight of a man. Other more local evidences of compression were seen in funnel-like depressions in the ice, in some cases with a dangerous hole in the centre, though the ice surrounding the hole was so strong that a man was able without risk to reach the hat of a skater who had fallen through. Evidences of the motion of the ice in the direction of the greatest pressure was also to be seen in bent and broken piles and landing-stages. These phenomena were not to be seen where from any cause the ice did not attain to any great thickness, as, for instance, at the mouth of Troutbeck, where the flow of the river checked the formation of the ice.

Scarcely less remarkable than the effects of the ice-action themselves was the short time that it took for denudation to remove all traces of them.

These are the facts that I observed; and I think they may be worth putting on record, especially because the opportunities of observing them are so rare, Windermere being seldom frozen over more than three or four times in a century. GEO. CREWDSON.

ST. MARY'S VICARAGE, WINDERMERE.
September 1st, 1904.

THE DISCOVERY OF MARSUPITES IN THE CHALK OF THE CROYDON AREA.

SIR,—Some few weeks ago I received a letter from Messrs. Wright & Polkinghorne (of the Battersea Field Club and Geologists' Association) to the effect that while cycling from Purley to Beddington they observed some chalk that had been thrown out while laying the sewer in one of the new roads at the top of Russell Hill.

Upon examining the chalk they were rewarded by finding plates of Marsupites. The following Thursday evening I accompanied Mr. Wright to the spot, when we found that the chalk had been put back; however, after a diligent search among the blocks on the surface, we succeeded in obtaining five or six plates, two of which were embedded in flint nodules.

The nipple-headed form of *Bourgueticrinus* and the pyramidated form of *Echinocorys vulgaris*, both characteristic fossils of the Marsupite zone, were also obtained.

The chalk is of a very soft nature, quite different to that of the other zones in the district. I spent four hours the following Saturday at excavations at a lower horizon in the hope of finding *Uintacrinus*, but without success. I am bound to admit that the appearance of

this zone at this spot is quite a surprise, for, standing at Russell Hill one turns to the left, where at the Haling Pit the bottom beds of the *M. coranguinum* beds are exposed; while immediately facing us at the Purley Junction pits (now ceased to be worked) we have the *M. cortestudinarium* zone; the dip, as revealed by the successive zones to the Chalk escarpment, being to the north and disappearing under the Tertiaries at South Croydon.

One can only account for this zone by a fold in the Chalk, as we have at Beddington, a little further south-west, the upper part of the *M. coranguinum* beds exposed which are at a lower level, according to ordnance datum, than Russell Hill.

Subsequent discoveries will be watched with interest by all workers in Chalk geology.

G. E. Dibley.

7, Champion Crescent, Lower Sydenham, S.E.
August 29th, 1904.

EQUIVALENTS OF THE LOWER CULM.

Sir,—Mr. Jukes-Browne has pointed out to me that in my paper on the Homotaxial Equivalents of the Lower Culm I have left it uncertain what remains in North Devon as the representative of the Lower Carboniferous series, and that I might be understood to mean that there is absolutely no representative of the Carboniferous Limestone in that area. He also reminds me that Salter in 1863 mentioned the existence of soft fossiliferous shales containing Carboniferous fossils above the Pilton Beds to the north of Barnstaple, which I noted as passage beds (p. 397). He further suggests that my table of comparative succession (p. 401) might be amplified thus:—

Devonshire.	South-West Ireland.	
Lower Culm	*Posidonomya* beds.	
Fremington Beds	Carboniferous shales }	
Soft shales }	Carboniferous slate }	
Pilton Beds }	Carboniferous, lower part }	Upper
Baggy Beds	Coomhola Beds }	Devonian.

I am quite prepared to admit the possibility that the Lower Carboniferous series is represented in North Devon and in South-West Ireland, but at present I am not sufficiently conversant with the palæontology of the Pilton Beds to discuss the question. For its settlement, moreover, some further field-work would be required.

Wheelton Hind.

Stoke-on-Trent.
September 13th, 1904.

MISCELLANEOUS.

Eoliths: a Chance for Collectors!—We have learnt from Mr. Benjamin Harrison, of Ightham, that, with the kind permission of Sir Mark Collett, the present owner of the property, he has recently opened a fine section in the Eolithic Drift on Terrys Lodge crest. Mr. Harrison hopes that anyone desirous of studying this drift for themselves will take advantage of this opportunity.